MANAGEMENT PLAN FOR MOUNTAIN GOATS IN ALBERTA

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PREFACE

This plan represents the Fish and Wildlife Division's goals, objectives and management strategies for the management of mountain goats in Alberta. It will periodically be reviewed and updated as necessary. Implementation will be subject to priorities established during the budgeting process. This plan includes historical information up to the spring of 2001. Therefore, the limited hunting season, opened in Goat Management Area A in the fall of 2001, is not reflected in the plan. It will be included when the plan is updated in the future.

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MANAGEMENT PLAN FOR MOUNTAIN GOATS IN ALBERTA
EXECUTIVE SUMMARY

Historical Populations, Use and Management

In Alberta, mountain goats are limited to the narrow strip of mountains along the southwestern border. Mountain goat distribution is patchy because it is restricted by the limited availability of suitable cliffs associated with forage and other requirements. Mountain goats are specifically associated with rough, rocky, cliff and ledge complexes into which they retreat to escape danger.

There is little information on the historic numbers of mountain goats in Alberta, but estimates in the 1950s were 3000-4000. The animals were likely protected from early hunting and development by their remote and rugged habitat, but mountain goat populations were seriously depleted from Waterton Lakes National Park to the Athabasca River by the late 1960s. Estimates in the early 1970s placed numbers at about 1000 mountain goats in Alberta (outside the national parks), and only the wilderness areas had relatively high numbers, for example, about 500 in the Willmore.

Hunters in the first half of the 20th century focused on Alberta's other big game species. They did not value the mountain goat as a trophy or for its meat. This lack of interest, along with the species' remote habitat, meant the mountain goat received little management attention until the population collapsed in the late 1960s. This collapse has been attributed to inadequate hunting controls that were not addressing rapidly increasing development of road and trail access adjacent to mountain goat habitat. The 1960s included a series of very severe winters, which likely added to the problem. Monitoring efforts were significantly increased after the 1960s population decline.

Hunting regulations became increasingly strict throughout the 1970s and 1980s as mountain goat populations did not recover and continued to decline in some areas. The mountain goat hunting season was closed in Alberta in 1988 to allow populations to recover and to allow for wildlife biologists to evaluate the management program and collect information on mountain goat population biology. Since 1988, there have been several mountain goat transplants to repopulate historical mountain goat ranges and supplement existing populations, but they have been less successful than desired.

Current Status

Since the closure of hunting seasons in 1988, some mountain goat populations in Alberta have recovered to historic numbers. However, mountain goats have been slow to repopulate vacant habitats. In 1991, a population goal for the province was set at 2500 mountain goats by the year

2000. Recent surveys and estimates suggest there are only about 1650 mountain goats on provincial lands, and only 7 out of 35 surveyed areas have met the goals set in 1991.

The majority of the published literature on mountain goats is based upon recently introduced herds in more southern habitats without predators such as wolves. Therefore, this literature does not apply directly to the population dynamics of mountain goats in Alberta.

Management Goals, Objectives and Strategies for the Future

- All critical mountain goat ranges, particularly the core cliff areas, should be identified and protected from development and human activity. Road access should be carefully planned, monitored and controlled. Recreational activities such as heli-tourism, hiking and rock climbing are of special concern, but all disturbance should to be minimized.
- The primary objectives for mountain goat management in Alberta will be to restore depleted populations and maintain other populations. Goals have been established for 33 surveyed areas and an increase of 31 percent (from about 1300 to 1700) is targeted for these areas by the year 2010. These objectives can only be achieved using conservative hunting strategies.
- Most populations will not be available for hunting in order to meet the area-specific and provincial goals. Surveys will continue for 33 populations of mountain goats in the province at frequencies dependent on management objectives. Population compositions need to be determined for all survey areas that are being considered for a recreational hunt within the near future. Provincial standards will be developed for data collection, data storage, data analysis and report preparation.
- Prior to opening a limited entry special licence draw hunt in any Goat Population Area (GPA), the GPA must have a population goal of a minimum of 50 mountain goats, must have at least 10 years of survey data collected during years with no hunting, must be at or above the population goal, should have an adult male to female ratio above 1 to 3, and there must be aerial survey data for the previous year and the summer just prior to the proposed fall season opening. The harvest rate will be 3 percent or less of the total estimated summer population in a GPA that meets the criteria for a hunting season.
- Mountain goats have several attributes that make them particularly attractive for non-consumptive use. Methods should be evaluated to take advantage of non-consumptive use opportunities while minimizing disturbance of mountain goats.
- It is important to better understand the biology of the mountain goat, especially factors controlling its reproductive performance, mortality and use of various habitat attributes. Research should be expanded to include representative herds from southern Alberta.

1.0 INTRODUCTION

The mountain goat (*Oreamnos americanus*) is perhaps the least recognized and least known of Alberta's big game ungulates, probably due to the steep and rugged nature of its mountaintop habitat. Mountain goats have a white coat that contrasts sharply with black horns, hooves, eyes, and nose, yet people often confuse them with the more common, grey-brown colored female bighorn sheep (*Ovis canadensis*). Human development and use of mountain goat habitat has been minimal to date. Consequently, this habitat in Alberta remains much as it was a century ago.

Little was known about Alberta's mountain goats until the late 1960s, when a major decline in the population was detected. Some of the decline may have been related to severe winters such as that of 1964-1965, when goat numbers in the adjacent mountain national parks also declined sharply. However, the decline on provincial lands was compounded by increasing hunter harvests related to increasing road access developed mainly for industrial activities such as oil and gas, coal and logging. The harvest in many herds exceeded sustainable levels, and many herds had declined before the problem was recognized. At the time, other game species received higher priority for the limited management resources. Once the population declines were documented, seasons were increasingly restricted and closed locally, and eventually closed throughout all of Alberta in 1988. Since the closure of hunting, individual populations have recovered at different rates. However, the net increase in the overall provincial population since 1988 has been relatively small.

Much of the published literature on mountain goats is based upon recently introduced herds in more southern habitats without predators such as wolves. Therefore, this literature does not apply directly to the population dynamics of mountain goats in Alberta.

This plan reviews the biology of mountain goats, as well as their history and management in Alberta. It also summarizes the current status and use of the species and its habitat in the province. Finally, it outlines goals, objectives and management strategies for the future conservation and use of mountain goats in Alberta.

2.0 BACKGROUND

2.1 BIOLOGY

2.1.1 Taxonomy

Mountain goats are Artiodactyls (even-toed ungulates) and members of the family Bovidae, sub-family Caprinae and the tribe Rupicaprini (Hibbs 1966, Rideout and Hoffman 1975). The only living species of its genus, *Oreamnos americanus* is most closely related to the chamois (*Rupicapra rupicapra*) of Europe, and the serow (*Capricornis* sp.) and goral (*Naemorhedus* sp.) of Asia (Casebeer et al. 1950, Wigal and Coggins 1982, Chadwick 1983). Chadwick (1983) provides an excellent and detailed discussion of the taxonomic and evolutionary development of *Oreamnos*

Although the taxonomy is still open to debate (Rideout 1978), four subspecies of the mountain goat have been named: *O. a. missoulae* in Alberta, southeastern British Columbia, Montana and Idaho; *O. a. americanus* in western British Columbia and Washington; *O. a. kennedyi* in the Copper River area of Alaska; and *O. a. columbiae* in northern British Columbia, Yukon and southern Alaska. Cowan and McCrory (1970) examined 167 skulls and found no cranial features diagnostic of these subspecies and concluded there was no justification for the subspecies designations.

2.1.2 Description

The mountain goat's white pelage is fine, dense wool overgrown by long guard hairs, which are up to 20 cm long over the back and legs when the animal is in full coat. The long guard hairs form a prominent beard and create the characteristic high-shouldered shape. Except for black hooves, horns, eyes, and nose, goats usually are all white, although their coats are frequently yellowed or stained. Some individuals have sufficient brown hairs scattered along the back to form a narrow, dark dorsal line (Holroyd 1967, Rideout 1978). Such a line is often apparent on kids observed during midsummer aerial surveys in Alberta. It was also noticed on most young goats in a South Dakota population transplanted from Alberta (Harmon 1944, Hanson 1950 in Brandborg 1955, Richardson 1971). This dorsal line tends to disappear as goats age.

The goat's shaggy, dense coat provides appropriate camouflage and insulation for living in a cold climate with persistent snow patches. Most biologists consider the goat's heavy coat an adaptation to the harsh climate. Although its coat provides adequate insulation, it is not as effective as coats of truly arctic mammals (Krog and Monson 1954). Goat's fur is not fed by oil glands and therefore is not very moisture repellent (Casebeer et al. 1950). Many authors have observed goats quickly seeking shelter from heavy, cold rains and wet snows.

Goats molt their hair annually beginning about early May, although the date depends on locality, as well as sex, age, condition and reproductive status of the individual. There is considerable variation in timing of the molt, but generally, adult males are the first to both begin and complete the process. Adult females with kids are the last, often still shedding in August. The date and stage of molt are helpful in identifying the sex and reproductive status of individuals (Brandborg 1955, Chadwick 1983). Most goats will have completed molting by early August and the new, short coat provides relief from late summer heat. The new hair grows steadily, and a full winter coat is developed by late fall.

Mountain goats are relatively stocky with short, thick legs. Much of the body mass seems concentrated in the front quarters, which are topped with a slight hump. However, the long hair exaggerates both the goat's size and this front-heavy, humped appearance. The front legs and shoulders are heavily muscled and powerful, indicative of the goat's reliance on its front quarters for climbing in its steep habitat.

Within sex and age classes, mountain goat sizes vary considerably, the differences presumably being dependent on environmental conditions, such as habitat quality and climate. Table 1 provides sizes and measurements of goats at various stages of growth. K.G. Smith et al. 1995 indicates that kids are born with an average weight of 5.5 kg and gain approximately 0.2 kg/day within the first five months. Females reach maximum body mass of about 70 kg by three to four years, whereas males continue their growth until five years, reaching weights of 70 kg - 120 kg (Table 1). As adults, males are generally 10-30 percent larger than females (Brandborg 1955, Rideout 1978, Houston et al. 1989).

Both sexes have slender, pointed, black horns, about 25 cm long on adults (Brandborg 1955). Not visible at birth, the horns grow 5 cm - 8 cm in the first year, double their length in the second year, and reach about 20 cm by age three. Horn length (mm) of goats within the first five years of life can be predicted by the equation $[L = 39.93(\text{Age}) - 2.73(\text{Age}^2) + 115.75]$ for males and $[L = 39.93(\text{Age}) - 2.73(\text{Age}^2) + 97.96]$ for females (Côté, Festa-Bianchet and Smith 1998). Subsequent horn growth is slow. Goats can be aged by counting growth rings that form around the horns annually after the first year (Stevens and Houston 1989). Horn shape also differs between sexes. The horns of males are thicker and curve smoothly backward from base to tip, whereas the more slender horns of the female tend to grow straight up from the base and then bend more sharply

Table 1. Mountain goat morphology.

Age Class	Sex	Age (months)	Weight (kg)	Total Length (cm)	Shoulder Height (cm)	Reference
Neonate	Both[a]	0	3	56	34	Wigal and Coggins 1982
	Both	0	5.5	-[b]	-	K.G. Smith et al. 1995
Kid	Both	5	33	-	-	K.G. Smith et al. 1995
Yearling	Female	12	36	-	-	Festa-Bianchet et al. 1992
	Male	12	39	-	-	Festa-Bianchet et al. 1992
	Both	-	-	96	62	Wigal and Coggins 1982
Adult	Female	>36	71	-	-	Festa-Bianchet et al. 1992
	Male	>36	86	-	-	Festa-Bianchet et al. 1992
	Male	>24	70-120	125-180	92-110	Carr and Smith 1990

[a] Both means male and female.

[b] The dash means data not available.

backward near the tip. Crescent-shaped supraoccipital glands lie behind the horn bases of both sexes but are more prominent and active in males. These glands are thought to function in the species' rutting behavior (Geist 1964).

The hooves of the mountain goat are uniquely adapted for its environment. Large hooves and prominent dewclaws facilitate the animal's movement through deep snow. The digits are also protected by hard outer shells with sharp edges that catch and hold on the slightest of projections. Protruding slightly beyond each shell is a pliable, convex pad, which provides surefooted traction on rocks that are often steep, smooth and slippery.

2.1.3 Life History

Mountain goats are polygynous and breed between early November and mid-December (Geist 1964). Males are particularly active, moving from herd to herd in search of estrous females, and tend such females throughout their two to three day receptive period (DeBock 1970, Chadwick 1983). Females at Caw Ridge, Alberta, first breed at 3.5 years and produce their first young at four years of age (Festa-Bianchet et al. 1994). Other studies have shown younger females breed (Stevens 1980, Bailey 1991). C.A. Smith (1984) found 38 percent of two-year-olds (n=8) produced young in a rapidly increasing native population in Alaska. Houston et al. (1989) compared wild and captive goats and suggested that females may need to reach a body mass of 70 kg, irrespective of age, before becoming sexually mature.

Gestation takes about 180 days between the breeding peak of 1 December and the peak birthing date of 1 June. As parturition approaches, pregnant nannies seek seclusion, often in the steepest, roughest terrain in their range. A single kid is born around 1 June. Twinning is very rare in Alberta; only two sets of twins were found (n= 12 females) on Alberta's Caw Ridge between 1989 and 1992 (Festa-Bianchet et al. 1994). Twins are more common in low density populations on high quality, productive ranges (Holroyd 1967, Hibbs et al. 1969, McFetridge 1977, Hayden 1984, Foster and Rahs 1985, Houston and Stevens 1988). Triplets have also been reported on rare occasions (Lentfer 1955, Hayden 1984, Hoefs and Nowlan 1998).

Kids are precocious, moving about on steep slopes within hours of birth. Mothers are highly attentive, nosing and licking kids frequently. Kids nurse at frequent intervals, the bouts lasting from a few seconds to about 10 minutes (Brandborg 1955, Chadwick 1983). Mother and kid remain in close proximity during the kid's first days, seldom more than a few meters apart and often touching, as the kid sleeps on the uphill side of its mother, or hustles to safety between her legs at the first sign of danger (B.L. Smith 1976, Chadwick 1983).

Nursing becomes less frequent and of shorter duration within 10 days (Stevens 1980) and effectively terminates by late August. Kids begin eating forage and ruminating only a few days after birth, and they forage regularly with their mothers by six weeks of age (Brandborg 1955, Chadwick 1983). About one to two weeks after birth, nannies and kids rejoin other females and young in small nursery herds on favorable summer ranges. Yearlings also join these nursery herds, but two-year-old males gradually assume the more solitary existence favored by adult males.

Kids remain with their mothers through their first winter, benefiting from their mother's high social status with its privilege of priority access to the best foraging sites (Chadwick 1983, Mastellar and Bailey 1988). Although orphaned kids can survive the winter (Foster and Rahs 1982), the chances for kid survival are likely enhanced substantially if the mother is present to break trails and paw for forage through deep snow in the often harsh environment of goat winter ranges (Chadwick 1983). As spring progresses, nannies become increasingly less tolerant of their kids, eventually abandoning them as they prepare for the birth of another.

Yearlings are often associated with their mother (Festa-Bianchet pers. comm.). Yearlings are also part of nursery herds and undoubtedly benefit from the association, but they are kept at what the nannies consider to be a safe distance from their kids. The winter mortality of yearlings averaged 21 percent during 1987 to 1999 at Caw Ridge, Alberta, compared to adult winter mortality, which averaged 14 percent (K.G. Smith et al. 1999).

2.1.4 Behavior

Mountain goat behavior has been described broadly by DeBock (1970) and Chadwick (1983). Others have studied more limited aspects of behavior, such as breeding (Geist 1964), effects of snow cover (Petocz 1973), highway crossing (Singer 1978) and agonistic behavior at winter feeding sites (Masteller and Bailey 1988). Although not all forms of behavior (e.g., comfort and play) are considered in the context of this management plan, certain aspects of goat social behavior are reviewed because of their importance in the biology and management of the species.

As described by Chadwick (1983), mountain goats defend a mobile personal space and the structure of the herd is based on a dominance hierarchy. Dominance is determined largely by the sizes of competitors but is also influenced by their health and vigor. Kids are dominated by yearlings, yearlings by two-year-olds and two-year-olds by adults. Within any age and sex category, dominance, between any two goats, is asserted by the larger, healthier, more vigorous individual. In adults, age is important because hierarchical position improves with increasing size and experience during the prime years, and declines in old age as health and vigor deteriorate. Fournier (1992) found that dominance increased in female goats until the age of seven after which dominance dropped slightly.

Because of their greater size and strength, males as young as two years old are capable of dominating females. However, the presence and behavior of these emerging adults often initiates aggression from protective nannies within nursery herds. To avoid such conflict, sub-adult males move to the periphery of the herd and eventually to a solitary existence or into a bachelor band. This segregation reduces the chances for conflict-induced injuries to smaller females and young, and may result in a more optimal use of limited habitat resources. Adult females, by size alone, dominate the nursery herds. Nursing females have the added motivation of protecting their kids (Côté et al. 1997).

Dominance is asserted by a behavioral repertoire that escalates from staring and foot stomping to a "present threat" or "rush threat" with horn swiping. These threats are mostly display but can lead to stern prodding or vicious stabbing. These behaviors and others are described in detail by Geist (1964), DeBock (1970), Dane (1977) and Chadwick (1983).

Dominant goats are approached with caution and generally given first access to the best sites for obtaining food, shelter, comfort or protection. Thus the largest, strongest, healthiest and the most reproductive nanny of the herd claims the most suitable environment. By protecting her mobile personal space, the dominant nanny may provide herself and her kid with the best environment and the best chance for survival. However, Fournier (1992) found that foraging efficiency was not significantly higher for dominant females.

Only during the rut do adult males regularly associate with females and the nursery herds. Males begin appearing on the fringes of the nursery herds about mid-October. Most early rut activity in males comes from 2.5 year-old males. They are no longer intimidated by adult nannies because they are now larger. However, the advances of these young males usually are rejected vigorously by females not yet receptive. In November, adult males become increasingly involved in rutting activities, continually searching for estrous females. The presence and dominance of these older males quickly moves smaller, younger males to a peripheral role and serves to maximize breeding by the biggest and strongest males. Males mark vegetation by rubbing the horn glands along flexible shoots, and dig rutting pits while sitting and using their front feet to toss urine-soaked soil against their sides and belly. During the rut, adult males can be identified at a considerable distance by their mud-stained coats.

As the rut progresses, females become increasingly tolerant of males, allowing their close proximity. A tending relationship may develop, in which a pair seeks seclusion from the others (DeBock 1970). The male guards the female from the approaches of other males if they are subordinates. Courtship proceeds with continual examination of the female leading to a foreleg kick between her hind legs, mounting and copulation when she is fully receptive. The process may be repeated many times until estrous terminates and the male moves off to search for currently estrous females. The rut diminishes with advancing winter and terminates about mid-December. Nannies revert to protecting kids, and the rejected males withdraw from the nursery herds. Resuming their near-solitary existence on separate winter ranges, males leave the best of the secure ranges and limited forage to the nannies.

The described behaviors are significant in mountain goat management. Sexual segregation and the solitary existence of males lead to difficulties in determining or interpreting sex ratios. Often alone, males are more difficult to find than the larger nursery groups. Surveys during the rut, especially ground surveys, should improve the situation because of the increased visibility of males, and lead to more accurate sex-ratio data. Group sizes, age-sex associations and individual behavior may be useful tools to focus harvest on specific cohorts if goats are hunted.

2.1.5 Habitat Requirements

Around North America, mountain goat habitat varies from dense coastal forests at sea level in Alaska (C.A. Smith 1986) and British Columbia (Hebert and Turnbull 1977) to alpine tundra over 4300 m above sea level in Colorado (Hibbs 1967). The atypical Pinto Creek herd in Alberta survives along a small river valley in the foothills nearly 56 km from the mountains (Stelfox and Kerr 1962, Kerr 1965, K.G. Smith 1982, Harrison 1999). Climatic conditions range from xeric to extremely wet, with winter temperatures from reasonably mild to bitter continental colds. The moderate temperatures along the coast occur with deep snow that creates an environment often as harsh as goat habitats elsewhere.

Goat habitats are dominated by cliffs or at least extremely steep rocky slopes (Kerr 1965, Holroyd 1967, McFetridge 1977, Stevens 1980, K.G. Smith 1982, Johnson 1983, Chadwick 1983, Von Elsner-Schack 1986). Crags, pinnacles, loose rock, and rubble are common. The most suitable bands of cliffs are often broken by narrow chutes leading onto talus or lush avalanche slopes. They are interspersed with or adjacent to shoulders of less precipitous land growing quality forage. Although sometimes suggested as a means of avoiding competition with mountain sheep, most authorities consider the adaptation to cliffs has evolved to protect goats from terrestrial predators.

2.1.5.1 *Cover*

Cover for goats is provided primarily by cliffs intersected with ledges. Such cliffs provide basic security for the mountain goat as none of its natural predators can match its agility around this near-vertical habitat. Nannies seclude themselves in the least accessible and most secure of crannies for parturition and the first days with their neonates (Von Elsner-Schack 1986). Nursery herds, especially the nannies with kids, seldom venture more than 400 m from the escape terrain offered by these cliffs (McFetridge 1977, Stevens 1979, K.G. Smith 1982, Chadwick 1983, Harrison 1999). Even the larger, stronger adult males remain in reasonable proximity to such cliffs most of the time.

Cliffs and associated features are also important for climate modification and thermal regulation. Compared to more level surfaces nearby, steep slopes and cliffs receive less snow per surface-area unit and shed it more readily. Large cliff complexes are usually windswept, further reducing snow accumulation. Those cliffs used for winter ranges tend to have south or west exposures that maximize solar radiation, ambient temperature and snow melt. These cliffs provide for greater mobility and access to forage than would be possible on flatter surrounding areas with deeper snow.

Overhangs, caves and the lee sides of rocks and ridges provide shelter from severe wind chill and snowstorms. Dense growths of conifers, when present near cliffs, provide similar protection. Kerr (1965) noted that conifers, shrubs or both occurred on 76 percent of the goat winter ranges he found in west-central Alberta. In British Columbia and Alaska, dense coniferous canopies are instrumental in intercepting heavy coastal snowfall, reducing snow accumulation on the ground and easing mobility and foraging by goats. In summer, such features provide protection from cold, soaking rains, as well as from direct sunshine and excessive heat. An important function of summer habitat is to provide goats with relief from heat, especially females, whose heavy coats may not molt until August. In summer, lush, cool habitats at higher elevations or on north and east facing slopes are preferred. Ridge-top habitats are desirable because they enable goats to adjust their microclimate simply by moving across the ridge to a different aspect (Stevens 1980). Lingering snow banks provide cooling on hot days and excellent camouflage for the white goats as well. Where snow is absent, moist soils enable goats to dig cool depressions in which to lie.

2.1.5.2 *Forage*

The mountain goat is not a specialist forager. Its food habits, described from many parts of its range, show the ingestion of a wide variety of plant materials (Casebeer et al. 1950, Brandborg 1955, Hibbs 1967, Johnson et al. 1978, Adams and Bailey 1983). Goats will eat almost any herbage, including species not normally used by other ungulates (e.g., bearberry/kinnikinnick, *Arctostaphylos uva-ursi*; Canada buffaloberry, *Shepherdia canadensis*; silverberry, *Elaeagnus commutata*; shrubby cinquefoil, *Potentilla fruticosa*). Shrubs and trees are browsed and their bark stripped; grasses, grass-like plants, forbs, ferns and mosses are grazed; lichens are pulled from trees or scraped from rocks; and even roots are dug up and eaten.

Although goats eat a wide variety of foods, they also specifically select flower heads, culms, foliage or buds, presumably the most nutritious plant parts (Casebeer et al. 1950). Goats have been described as snip feeders that seldom graze intensely at one spot (Saunders 1955). Some forages such as wheat grasses (*Agropyron* spp.), bluegrasses (*Poa* spp.), sedges (*Carex* spp.), grouseberry (*Vaccinium scoparium),* saskatoon (*Amelanchier alnifolia),* choke cherry (*Prunus virginiana),* red-osier dogwood (*Cornus stolonifera),* penstemons (*Penstemon* spp.) and arboreal lichens (*Lobaria* spp.) seem to be preferred. Goat diets frequently include conifers, particularly firs (*Abies* spp.) (Saunders 1955, Geist 1971, Chadwick 1973, B.L. Smith 1976), but heavy consumption of such plants often seems to be associated with severe winter conditions (Geist 1962, Kerr 1965, Geist 1971, Johnson 1983). Rumens from carcasses of several winter-killed goats in Montana contained largely needles of pine (*Pinus* spp.), fir (*Abies* spp.), juniper (*Juniperus* spp.) or spruce (*Picea* spp.) as noted by Casebeer et al. (1950). One nanny had starved with 6 kg of pine and Douglas fir (*Pseudotsuga menziesi)* needles impacted in her stomach.

This generalized foraging strategy is significant for goats because they limit their potential choice of foods to plants available near cliff habitats. Larger herds can be supported by a greater amount of preferred forage in proximity to escape terrain. Goats, particularly nursery groups, seem to select habitats that are topographically secure; then they eat whatever is available there (Johnson 1983). However, seasonal variation in forage and habitat selection suggests that security needs become less constraining as kids age and the need for abundant quality forage increases.

Depending on local vegetation, foods vary substantially between regions and seasons. Grass-like plants seem to be preferred in most areas and are used year-round if available (Saunders 1955, Hibbs 1967, Chadwick 1973, B.L. Smith 1976, Johnson 1983). Although heavily used in summer in some areas (Anderson 1940 in Brandborg 1955, Casebeer et al. 1950), browse is more likely to be important in winter, especially when herbaceous forage is deeply buried in snow (Brandborg

1955, B.L. Smith 1976) or where shrub communities cover the winter range (Kuck 1971). Arboreal lichens are used mainly where goats inhabit forests to escape deep snow or excessive heat, but they seem to be both preferred and nutritious forage (Brandborg 1955, Richardson 1971, Chadwick 1973, B.L. Smith 1976, Fox and K.G. Smith 1988). Forbs are most used in summer (Chadwick 1973, B.L. Smith 1976), and the flowers of many species are especially preferred.

In Alberta, the food habits of goats have been recorded in Banff and Jasper National Parks (Cowan 1944), and the Willmore and Pinto Creek areas (Kerr 1965, McFetridge 1977, K.G. Smith 1982). In the Willmore and Pinto Creek areas, browse contributed substantially to diets throughout the year and appeared to be the primary forage in winter. Important species were saskatoon, silverberry, rose (*Rosa* spp.), aspen (*Populus tremuloides*), snowberry (*Symphoricarpos* spp.), alder (*Alnus crispa*), alpine fir (*Abies lasiocarpa*), lowbush cranberry (*Viburnum edule*) and willow (*Salix* spp.). In general, grass consumption appeared to be relatively highest in spring and fall but slightly lower in summer, when forbs made their greatest contribution. This information was based on samples from only four rumens (Kerr 1965). Based on five rumens, Cowan (1944) found 63 percent grasses and sedges, 14 percent forbs, and 23 percent browse in summer diets.

2.1.5.3 *Water*

Although the daily water requirement is unknown, a captive goat in South Dakota drank 3.75-7.5 liters on hot days but only about 1.9 liters on cool, rainy days (Richardson 1971). On warm, dry summer ranges, goats went to water at least daily (Anderson 1940 in Johnson 1983) and vacated areas when water dried up (Johnson 1983). Absence of readily available water may explain the absence of goats from otherwise suitable areas (Wigal and Coggins 1982). Available moisture must also be closely associated with escape terrain, from which goats are reluctant to venture more than about 400 m.

The lack of water has seldom been a problem for studied populations because goats inhabit primarily alpine areas with water or latent snow present during the summer (Hibbs 1966, Holroyd 1967). Many authors have watched goats drink water, though seldom as if driven by any great need or thirst (Casebeer et al. 1950, Brandborg 1955). Goats seek the cool proximity of snow banks and are frequently observed eating snow, which may provide much of the required water in hot weather.

Kerr (1965) watched goats go several days without water, and even then, approached streams with little apparent interest. Goats may obtain much of their water requirement from forage. In summer, their use of cool, moist sites with succulent vegetation is well documented. Showers and morning dew occur frequently in alpine habitats and may also help meet the requirement for water. Rideout (1974) noted a predawn activity peak coincident with moisture on vegetation.

2.1.5.4 *Minerals*

Like other ungulates, mountain goats frequent available mineral licks, drinking the liquids and licking at the materials present. Goats use licks primarily in May, June and July but occasionally throughout the rest of the year (Brandborg 1955, McCrory 1965, Hebert 1967, DeBock 1970, Singer 1975, Stevens 1979). All sex and age groups use salt licks, although the timing varies. Males use licks most often in spring (Singer 1975). Females with young visit more regularly in summer as kid mobility increases, enabling them to venture farther from escape terrain. Singer and Doherty (1985) described the frequency and movement associated with licks in Montana and found that nannies in Montana visited licks less often than billies.

The importance of mineral licks seems to vary substantially. The nutritional or psychological attraction may result in goats travelling through forested areas far from escape terrain. Some goats swam the middle fork of the Flathead River to reach the Walton Lick in Glacier National Park, Montana (Singer 1975). Some authors think that summer ranges are restricted by the urge to stay close to licks. Other herds use nearby salt regularly but do not seem to travel great distances to get it (Richardson 1971). Goats on Mount Hamell in west-central Alberta apparently did not use licks at all, even though two were present in the vicinity (Kerr 1965). The Mount Hamell herd was healthy, suggesting that lick use was not a nutritional requirement for this herd.

The mineral constituents and their concentrations vary considerably among licks and relative to surrounding soils. Both factors undoubtedly affect the attractiveness and the nutritional value of licks. Sodium is considered by many to be the key element in mineral licks (Hebert and Turnbull 1977). Sodium chloride is certainly attractive to ungulates, and a sodium deficiency is likely in ungulates feeding on lush green forage in spring (Hebert and Cowan 1971a). Other elements often thought to be significant are phosphorus, calcium and copper (McCrory 1967).

2.1.5.5 *Space*

Mountain goats are relatively slow moving, sedentary creatures that associate in small groups usually restricted to small areas. Seasonal ranges often exist at different elevations or aspects on the same mountain or ridge. Suitable forage and water, as well as cover for escape and climate selection, are required for all seasons but are most valuable if juxtaposed. Because goats, especially females with young, are reluctant to venture more than 400 m from escape terrain, the space they utilize is small, usually limited to the vicinity of suitable cliffs. Males and yearlings range farther from escape terrain and take advantage of a wider range of habitats. Because adult males and nursery herds are separated at most times of year, suitable habitat must exist for both cohorts.

Seasonal ranges of goats are usually somewhat separate so annual home ranges are larger than seasonal ones. There have been few comprehensive studies of mountain goat home ranges, but Rideout (1977) reported annual home ranges of 48.3, 31.1, 24.0 and 21.5 km^2 for yearlings, two-year-olds, adult females and adult males respectively in Montana. He attributed the large size of yearling ranges to the fact that adults repeatedly chase yearlings away, causing them to move continually from group to group. The smaller area of adult male ranges seems suspect because of the small sample size. Females traditionally use the same summer and winter ranges in subsequent years (B.L. Smith 1976, Rideout 1977). Large summer ranges continually shrink as snow accumulates into the winter. B.L. Smith (1976) found winter range sizes averaged over 40 ha; however, more than 75 percent of goat observations were clustered on high use areas of only 1.5 ha - 7.0 ha. B.L. Smith (1976) also found the winter home ranges of adult females to be largest (72 ha or less), but he had few observations of males.

2.1.5.6 *Security*

Mountain goats are capable climbers, reacting to danger by retreating to rock and cliff areas (C.A. Smith 1982). Seclusion becomes significant when goats are disturbed by humans. An exposed ledge offers little protection from disturbances involving hunters, mountain climbers or helicopters. Human disturbances, unlike the passing of a predator, are often more frequent, persistent and intense. Goats have dispersed in search of greater seclusion when faced by steady disturbance from road construction and traffic, logging or mineral exploration adjacent to their ranges (Pendergast and Bindernagel 1977, Wright 1977, Chadwick 1983, Sopuck 1985, Joslin 1986). Intensive recreational activities can be expected to have the same effect (Johnson 1983).

Even if goats are not totally displaced by such activities, they may be more closely confined to escape terrain and unable to efficiently use the less secure parts of their range. It is likely that goats require adequate seclusion, in addition to escape terrain, to feel secure around human developments and activities. Although variable and dependent on the situation, goats appear to become intolerant of human activities and disturbance at about 300 m (Chadwick 1976, Wright 1977, Johnson 1983).

2.1.6 Movements

Mountain goats are relatively sedentary, and their movements are more steady and deliberate than speedy. If not disturbed, they can spend weeks in the same small area (Kerr 1965). At other times they can travel several kilometers in a few hours (Brandborg 1955, Johnson 1983).

2.1.6.1 *Daily Movements*

Except for previously discussed movements to salt licks, most short-term or daily movements are minimal. Especially on winter ranges severely restricted by snow, goats may spend weeks on only a few hectares (Brandborg 1955, B.L. Smith 1976). Although movements are less restricted in summer, they remain minimal (a few hectares) on quality ranges with a good juxtaposition of required resources. In summer, most movement is associated with feeding peaks in early morning and late evening, although this pattern is frequently altered by weather (Kerr 1965). In cooler weather, movements and feeding are more consistent, without prominent peaks of activity. During storms, goats tend to remain in shelter, emerging to feed as the weather moderates. Feeding stops when a good bedding site is reached and begins again at the same location when the goat arises (B.L. Smith 1976). Such coordination of activities conserves energy and is a substantial advantage available to goats whose habitats provide forage and bedding requirements in close proximity.

Nocturnal movements are minimal. Although movement has been recorded on dark nights (Rideout 1974), most movement is apparently associated with moonlight. A substantial range of activities has been observed but most relate to feeding or licking salt (Chadwick 1973). Nocturnal movements of over 3 km have been recorded, but long movements at night are apparently rare (Kerr 1965).

2.1.6.2 *Seasonal Migration*

Most substantial movements reported are related to seasonal changes in distribution from summer to winter ranges. These movements usually involve altitude changes of 1000 m - 5000 m, but the distances involved vary from 1 km - 2 km, with herds moving up or down the same mountain, to 24 km for herds with substantially separated seasonal ranges (Brandborg 1955, Holroyd 1967, Johnson 1983). Although not well documented for Alberta herds, anecdotal information suggests seasonal movements are relatively short compared to those mentioned above.

Long migrations often force goats through forests or other normally unsuitable habitat, away from the security of escape terrain. Males are often first to migrate, whereas females with kids are last because they are more restricted to escape terrain and delay travel until kids develop adequate mobility and coordination (Brandborg 1955, B.L. Smith 1976).

Seasonal movements are usually the result of conditions such as the availability of nutritious forage, which may mean movements to higher elevations in summer. Movements to winter ranges may involve changing elevation, up or down, or movements at the same elevation to find areas of low snow accumulation and available forage. The best and most favored habitats would be those with seasonal ranges in close proximity, minimizing hazardous travel away from secure escape terrain.

2.1.6.3 *Dispersal*

Mountain goats can undertake major dispersal movements, especially under high population density. Stevens (1980) recorded dispersals of 16 km - 93 km from Klahhane Ridge, Washington, with a density of 14 goats/km^2. In the Klahhane area, goats do not appear to repeat migrations longer than 16 km and do not return from movements greater than 42 km (i.e., permanent dispersal; Stevens 1980). Wandering goats are usually young males two to three years old, but females and older animals also disperse, making establishment of new populations possible. Alberta's Pinto Creek herd might have been established by such dispersal during a period of high population density. On Caw Ridge, Alberta, four males and three females were observed emigrating 12 km - 35 km from the ridge, while three males have immigrated since 1987 (K.G. Smith et al. 1999). K.G. Smith et al. (1999) found that almost 25 percent of the adult males (>2 years old) on Caw Ridge were immigrants. Dispersal likely performs an important role in determining the number of males in goat populations.

2.1.7 Reproductive Success and Survival

One of the key factors that led to declines in goat numbers in Alberta was the lack of knowledge of the capacity of goats to reproduce. Harvest levels for goats were set with the assumption that goats had kid production and recruitment levels similar to other ungulates.

Herd composition data are very sparse in the literature because of the difficulty in obtaining this data from aerial surveys. Long-term research at Caw Ridge provides an average population composition in a population that increased from 81 to 135 during the 10-year study (Table 2). The Caw Ridge information is the only reliable composition data from Alberta that can be used as a basis for population models. The low number of young goats and adult males in the population (Table 2) illustrates some of the following factors that influence population structure.

Table 2. Average June composition of goats at Caw Ridge, Alberta, 1990-1999 (Festa-Bianchet et al. 1994, Côté pers. comm.).

Age	Sex	Average Percent of Total Sample	Range in Percent Of Total Sample
Kid	Both	23	(20 – 30)
Yearling	Male	6	(2 – 11)
	Female	8	(2 – 13)
Adult	Male	18	(11 – 22)
	Female	45	(35 – 51)

Table 3. Kid production for marked female goats at Caw Ridge, Alberta, 1988-1993 (Festa-Bianchet et al. 1994).

Age (years)	Percent That Produced Kids	N [a]
1	0	17
2	0	20
3	0	16
4	29	17
5	71	21
6	67	21
7	70	23
8	79	14
9-10	82	17

[a] Number of female goats observed in the age group.

At Caw Ridge, only 29 percent of females give birth to kids prior to their fifth summer. Most females do not give birth until they are four years old, after which 73 percent of females produce kids (Table 3). Festa-Bianchet et al. (1994) found that there was no significant difference in age-specific kid production after four years of age, which does not mean, however, that the reproductive success of younger breeders is similar to that of older nannies. Reproductive success continually improves to peak at about eight years of age, declining thereafter (Stevens 1980, C.A. Smith 1984, Bailey 1991).

Because individual reproductive success can rarely be studied, managers need a measurable index of a population's reproductive success. One such index is the ratio of kids to adult females. Typical early summer ratios reported for Alberta vary from year to year between 40 and 70 kids/100 females (Brandborg 1955, Kerr 1965). The long-term average for the June population on Caw Ridge is 53 kids/100 adult females (Festa-Bianchet et al. 1994, Côté pers. comm.). The main sources of variation among reported ratios are the time of year in which the survey was done and the definition of an adult female. Comparisons among populations and between years should ensure calculations are made from similar data.

It is very difficult to identify the sex of adult goats during aerial surveys; therefore, managers that rely on aerial surveys often use the ratio of kids to adult animals (>1 year old) as an index of reproductive success. This ratio varies from year to year and throughout Alberta (mean = 0.30, Table 4) but has been generally lower in the Calgary/Bow Valley region (0.20, Table 4). The ratio also appears lower in hunted (0.29, Table 4) than in non-hunted populations (0.34, Table 4). These ratios should be interpreted cautiously because these data were collected under a variety of survey conditions by many different survey crews. Bailey (1991) found that the ratio of kids to older goats decreased as a population increased and leveled when the population was at carrying capacity.

Goats have relatively low kid production levels compared to other ungulates. They also have high kid mortality rates as shown in Table 5. On average, at least 32 percent of kids born in west-central Alberta do not survive their first year (K.G. Smith et al. 1999) with most mortality occurring before November (Festa-Bianchet et al. 1994). Yearling mortality averages 23 and 20 percent for males and females respectively, and 20 and 11 percent for adult male and females respectively (Table 5). Chi-square comparisons of these data indicate that yearling male and female mortality is significantly higher than that of adult females (P=0.03 and P=0.06 respectively). Yearling mortality is not significantly different from adult male mortality. Adult female mortality is higher than adult male mortality, but the significance of the difference is not

Table 4. Average ratios of kids to adults (>1 year old) from aerial surveys of the four Goat Management Areas in Alberta. Surveys were excluded if less than 50 goats were observed or if more than 20 percent of the goats were unclassified. Surveys in the table were from populations that were not hunted unless otherwise stated.

Goat Management Area [a]	Years	N [b]	Goats Observed	Average	Range
A – Prairie Region	1990-99	6	649	0.29	0.23 - 0.38
B – Bow Region	1988-93	6	816	0.20	0.07 - 0.35
C – Parkland Region	1973-98	11	1363	0.29	0.19 - 0.40
D – Northern East Slopes Region – Unhunted	1974-98	20	5479	0.34	0.23 - 0.64
D – Northern East Slopes Region – Hunted	1973-87	13	3705	0.29	0.17 - 0.48
Totals		56	12012	0.30	0.07 - 0.64

[a] Boundaries of Goat Management Areas are shown in Figure 5.

[b] Number of years surveyed.

Table 5. Survival to following summer of marked goats on Caw Ridge, Alberta, 1987-1999 (K.G. Smith et al. 1999).

Age	Sex	Mean Annual Percentage		N [a]
		Survival	Mortality	
Kid [b]	Both	68	32	124
Yearling	Male	77	23	48
	Female	80	20	50
Adult	Male	80	20	158
	Female	89	11	417

[a] Number of goats observed in the age group.

[b] These data represent survival and mortality from the time of capture at 1-3 months of age.

strong (P=0.25). The difference in mortality between yearling males and females is not significant (P<0.50). Data from Alaska suggest that mortality rates increase dramatically with old age: 0-9 percent annual mortality between two and eight years old and 32 percent thereafter (C.A. Smith 1986). Few wild goats live past 11 years (C.A. Smith 1986). Except for a captive 20-year-old (Seton 1937 in Stevens 1980), the oldest individuals reported in the literature include an 18-year-old female and a 14-year-old male (Cowan and McCrory 1970).

Although it is useful to know the ratio of adult males to females for management purposes, it is not always possible to get accurate information due to the difference in probabilities of seeing adult males and females during surveys. Higher adult female survival (Table 5) at Caw Ridge has resulted in a long-term average sex ratio for adults of 41 males/100 females (1990-1999, range 27-55; Festa-Bianchet et al. 1994, Côté pers. comm.). Similar sex ratios have been reported from Montana (23-56; Rideout 1974, Chadwick 1973). Rideout (1974) found the lowest male to female ratios followed winters with excessive snowfalls, suggesting that mortality of males exceeded that of females during severe winters. It is suspected that a very low proportion of males to females will inhibit reproduction, but there is no evidence of such a relationship.

2.1.8 Limiting Factors

Several factors potentially limit goat populations, and any one may be the primary controlling factor at a particular time. Some that have been considered in various studies are discussed below.

2.1.8.1 *Parasites and Diseases*

A few studies have examined the parasites of mountain goats. Some populations carried heavy parasite loads, and most goats carried internal parasites. However, only a few of the examined individuals were infected to the extent of serious consequence (Cowan 1951, Brandborg 1955, Kerr and Holmes 1966, Boddicker and Hugghins 1969, Cooley 1976, Samuel et al. 1977, Johnson 1983). No evidence of mortality or serious damage directly attributable to parasites has been found in mountain goats in Alberta (Kerr and Holmes 1966, Samuel et al. 1977).

Most parasites have been considered of minor consequence for goats unless the goats were already stressed severely by other factors such as malnutrition during severe winters (Kerr and Holmes 1966, Richardson 1971, Cooley 1976). There is evidence that parasites and diseases may play a significant role in regulation of some goat populations. Johnson (1983) compared kid survival rates from two herds, one with high roundworm levels, and another dewormed with phenothiazine salt blocks. The untreated herd had high parasite loads and 100 percent kid mortality, but the treated herd had only 20 percent kid mortality.

About 30 species of helminths have been recovered from the mountain goat. Nineteen species (14 nematodes and 5 cestodes) have been found in Alberta goats (Cowan 1951, Kerr and Holmes 1966, Cooley 1976, Samuel et al. 1977, Pybus et al. 1984) with total loads ranging from 33-5,314 worms/goat (Samuel et al. 1977). Although helminth infections range from mild to extreme, their effects are dependent more on the species involved, the condition of the host and associated circumstances than on numbers alone.

Lungworms (*Protostrongylus stilesi* and *Protostrongylus rushi*) are host specific to native sheep and goats, and are common in all populations (Samuel et al. 1977). They coexist with goats in most circumstances. However, *P. stilesi*, which lives in the lung parenchyma causing some tissue damage (Boddicker et al. 1971), is pathogenic and may predispose goats to pneumonia. Although no major die-off of goats has been attributed to a lungworm-pneumonia complex, such a complex remains suspect as a cause of goat mortality (Boddicker et al. 1971, Samuel et al. 1977, Johnson 1983). Alberta is the only area where *P. rushi*, which lives in the air passages, has been found to occur with greater prevalence than *P. stilesi* (Samuel et al. 1977). *P. rushi* could block air passages and impair lung function (Boddicker et al. 1971), but it seems relatively benign in most cases, and its greater prevalence in Alberta is not likely significant. Cooley (1976) felt that lungworms (*Protostrongylus* spp.) were not a serious problem in Alberta goats even though 78 percent of examined fecal samples were infected.

Stomach worms, especially *Ostertagia circumcincta* in Alberta, are common and sometimes found in high numbers. *Marshallagia marshalli* is also common in goats. *Nematodirus maculosus* is the most prevalent of several species occurring in the small intestines. *Skrjabinema ovis* and *Trichuris schumakovitschi* have been found in the caeca and large intestines of Alberta goats, but they appeared to have little effect. Light infections of gastro-intestinal worms are common and seem to be of little consequence, but major infections are potentially debilitating and have been implicated in mortality of individual goats (Boddicker et al. 1971, Johnson 1983).

Parelaphostrongylus odocoilei, a muscle worm common and sometimes pathogenic in Alberta mule deer, has been found in skeletal muscles of mountain goats from Washington and Alberta (Johnson 1983, Pybus et al. 1984). Hemorrhages in the muscle tissues were associated with the adult worms. A Washington goat, from which about 65 worms were recovered, died in a weakened and emaciated condition, although the actual impact of the worms was uncertain. Pybus (pers. comm.) has since collected *P. odocoilei* from two goats in the Lake Louise and Hinton areas, and dorsal-spined larvae (probably *P. odocoilei*) were detected in 13 of 15 fecal samples from the Pinto Creek area (K.G. Smith 1982). Muscle worm may be a normal parasite of mountain goats, but neither the extent of infection nor the effect on goats have been examined adequately.

The five cestodes (*Avitellina* sp., *Moniezia benedini*, *Thysanosoma actinoides*, *Taenia hydatigena*, and an unidentified Anoplocephalidae) were found with low prevalence and light intensity in Alberta goats (Samuel et al. 1977). They appear to be of little consequence, although larval migration of *T. hydatigena* can cause extensive liver damage (Boddicker et al. 1971).

The protozoan parasites causing coccidiosis (*Eimeria* spp.) have been found in mountain goats (Brandborg 1955, Shah and Levine 1964, Todd and O'Gara 1968). Johnson (1983) reported that 93 percent of 14 goats examined and 97 percent of 225 fecal samples collected in Washington were positive for *Eimeria* spp. This parasite is sometimes pathogenic, and it can be fatal in domestic animals. Although Johnson (1983) did not observe clinical coccidiosis in mountain goats, he thought the intensity and prevalence of infections suggested borderline disease. He also reported 1 goat with *Sarcocystis* sp. In Alberta, Mahrt and Colwell (1980) found this protozoan in 11 of 15 goats examined, but its effects on goats are unknown.

The ticks *Dermacentor andersoni* and *Dermacentor albipictus* have been found on goats during spring (Cowan 1951, Brandborg 1955, Kerr and Holmes 1966). Hair loss around the shoulders and lower neck was attributed to goats scratching and rubbing areas irritated by ticks. Goat mortality caused directly by ticks has not been reported, although heavy infestations have been found occasionally. Ticks have caused weakness, emaciation, anemia and nervous disorders in other species and could lead to hair loss and stress that might affect survival during severe weather.

Other ectoparasites collected from goats are the spinose ear tick (*Otobius megnini*) (Cowan 1951, Brandborg 1955), the biting louse (*Damalinia parallelus*) (Cowan 1951), the domestic sheep foot louse (*Linognathus pedalis*) (Brandborg 1955) and the chewing louse (*Bovicola oreamidis*) (Boddicker et al. 1971). None seem significant in goat ecology, although Kerr and Holmes (1966) mentioned a captive kid whose death was attributed to pediculosis.

There has been little study or evidence of any mountain goat disease being significant at the population level, but individual goats contract a variety of diseases. Brandborg (1955) reported pasteurellosis in one goat. Cowan (1951) reported two cases of tooth abscess and one of foot rot, all involving a fungal infection (*Actinomyces israeli*). Paratuberculosis, caused by the bacterium *Mycobacterium paratuberculosis*, has been confirmed in one goat in Colorado (Williams et al. 1978). Neoplasms or tumors are seen occasionally, and one goat in Washington died of starvation because of a fibroma blocking its mouth (Johnson 1983). In Washington, Johnson (1983) found antibodies to parainfluenza 3 and bovine virus diarrhea in 17 percent and 43 percent, respectively, of 35 goats examined. Although present in goats, the effects of these viruses on the population were unknown. Antibodies against viruses of infectious bovine rhinotracheitis, bluetongue or ovine progressive pneumonia were not detected.

Samuel et al. (1975) reported contagious ecthyma, a viral disease of domestic sheep and goats, in mountain goats from Kootenay National Park, but it has not yet been found in Alberta mountain goats. In western Canada, contagious ecthyma has also been found in many bighorn sheep herds associated with sources of artificial salt (Blood 1971, Samuel et al. 1975). Hebert et al. (1977) diagnosed it in two mountain goat kids from coastal British Columbia where neither artificial salting nor bighorn sheep could have been involved in its epidemiology. The likelihood of livestock involvement was also remote, indicating the disease occurs in goats under natural conditions.

Capture myopathy has been observed in goats captured in Alberta and British Columbia (Hebert and Cowan 1971b, Jorgenson and Quinlan 1996). Selenium or vitamin E deficiencies may have been predisposing factors to this condition, which is apparently triggered by the stress of vigorous exertion (Hebert and Cowan 1971b). Preventative measures should be taken whenever goats are to be trapped and handled (Chalmers and Barrett 1977, Johnson 1983, Robbins et al. 1985). Because such exertion and stress could be created by predator attacks or human harassment, this condition could be a mortality factor of concern for goat populations.

2.1.8.2 *Predators*

Many potential predators share mountain goat habitat, but few of them utilize steep cliffs to any extent. Adult goats in this habitat are not very vulnerable, but kids are vulnerable even though carefully protected by their mothers. On Caw Ridge, a nanny was observed ramming a wolf to allow her kid to escape (Côté et al. 1997). However, recent work by K.G. Smith et al. (1992; see also Festa-Bianchet et al. 1994) attributed the majority of kid mortalities to predation (93 percent). Most mortalities occurred before the end of November, so winter conditions did not adequately explain the high kid mortality (38 percent; Table 5). These data suggest that predators may be the most important limiting factor for goat populations in this area of Alberta.

Golden eagles (*Aquila chrysaetos*) and bald eagles (*Haliaeetus leucocephalus*) are frequently observed harassing goats, stooping at them in apparent attempts to cause a fall. There are four authenticated observations of eagles successfully preying on goat kids (Brandborg 1955, B.L. Smith 1976). Goats have been observed to react with fear, crouching or squatting down, when harassed by eagles, especially if surprised by their sudden approach (Chadwick 1973). Although some predation occurs, it is likely insignificant at the population level. No major evidence of goat predation has been found around eagle nests (Brandborg 1955), and successful predation has been verified only with very young kids.

Cougars (*Felis concolor*) occur on most goat ranges. Because of their ability to move in steep, rugged terrain, their stealthy ambush style of hunting, and propensity to stay with their food supply, cougars are often identified as the predator most likely to have an impact on mountain goat herds (Brandborg 1955, Rideout and Hoffmann 1975, Johnson 1983). There are several reports of goats killed by cougars but most are based on circumstantial evidence (Brandborg 1955, Holroyd 1967, B.L. Smith 1976, Burleigh 1978, Johnson 1983, Festa-Bianchet et al. 1994). A cougar was observed chasing goats on Mount Hamell, Alberta (D. Gladue pers. comm.). Festa-Bianchet et al. (1994) attributed 3 out of 14 young goat deaths on Caw Ridge to cougar predation. In view of the cougar's secretive nature and habit of hiding its kills, the level of cougar predation may be much higher than observed.

Other potential predators of mountain goats include lynx (*Lynx canadensis*), bobcats (*Lynx rufus*) and wolverines (*Gulo gulo*). There are no reports of goat predation by lynx or bobcats even though at least one or the other occurs on most goat range. Wolverines exist only at low densities, and few interactions with goats have been reported. Their predatory impact is likely insignificant, but there are accounts of unsuccessful chases (Guiguet 1951, Côté et al. 1997, K.G. Smith pers. comm.). Wolverines have been found on goat carcasses (Casebeer et al. 1950, Fox and Streveler 1986).

Coyotes (*Canis latrans*) are the predators most commonly associated with the mountain goat. Several have been observed chasing or harassing goats (B.L. Smith 1976, Johnson 1983), but there are no reports of coyotes actually killing them. Coyotes are considered a threat because even large herds usually retreat to secure sites when coyotes are present. Occasionally, goats act aggressively, facing the coyote, stamping the forefeet and even charging (Casebeer et al. 1950, Brandborg 1955, Chadwick 1973). Inexperienced kids, abandoned or separated from their mothers, would be easy prey (Casebeer et al. 1950). Brandborg (1955) identified goat hair in 19 percent of 68 coyote scats collected in the Red Butte area of Montana. Several authors have found goat carcasses on which coyotes have fed, but like the scats, they are more likely indications of scavenging than of predation (Casebeer et al. 1950, Brandborg 1955, B.L. Smith 1976).

Wolves (*Canis lupus*) are potentially significant predators of most goat herds north of the 49th parallel. Wolf predation on mountain goats has been documented (Cowan 1947, Carbyn 1974 [both in Foster and Rahs 1982], Fox and Streveler 1986, C.A. Smith 1986, Côté et al. 1997), and may be second only to grizzly bear (*Ursus arctos)* predation (Festa-Bianchet et al. 1994). Data from Caw Ridge show that 6 of 19 predator-killed goats were taken by wolves (Côté et al. 1997). Fox and Streveler (1986) found goat remains in 62 percent of wolf scats collected from goat habitat in Alaska. However, Huggard (1993) found goat material much less frequently (only 2 percent of diet biomass) in scats collected from the entire range of a wolf pack in Banff National Park.

Wolves are common around most goat ranges in Alberta. Huggard (1993) found that wolves preyed upon goats opportunistically and usually only encountered them when the goats were in valley bottoms, or when their location was predictable, such as at salt licks or avalanche slopes. Even if predation by wolves is minimal, their continual presence around goat habitat may severely restrict goat use of quality resources not immediately adjacent to escape terrain (C.A. Smith 1982).

Both black bears (*Ursus americanus*) and grizzlies occur on many goat ranges. Chadwick (1973; see also B.L. Smith 1976) noted that goats usually fled for considerable distance when aware of nearby grizzlies but appeared relatively unconcerned about black bears. The fact that both goats and grizzly bears frequent avalanche chutes, moist coulees and alpine meadows and eat some of the same plants, increases the potential for encounters. Grizzly bears have been observed chasing goats in Banff National Park (Holroyd 1967), on Caw Ridge (Festa-Bianchet et al. 1994) and Mount Hamell (D. Gladue pers. comm.). In the study on Caw Ridge, the majority of young goat mortalities (6 of 14) were attributed to grizzly predation (Festa-Bianchet et al. 1994). Côté and Beaudoin (1997) documented one successful attack and four unsuccessful attacks on goats by grizzly bears at Caw Ridge in 1996. These data suggest that grizzly bears can have a significant impact on the survival of mountain goats.

2.1.8.3 *Human Disturbance*

There is limited quantitative information regarding the influence of various types of human disturbance on mountain goats. In contrast to bighorn sheep, which are easily habituated to humans, Geist (1978) notes that mountain goats tend to remain flighty and far less approachable. If prolonged, stress can be expected to result in organ damage, reduced viability and early death (Geist 1978, Stemp 1983). In contrast, Penner (1988) suggests that the atypical forest-dwelling goats at Pinto Creek, Alberta, are adaptable and can habituate to potentially adverse stimuli if they are gradually acclimatized and negative associations are avoided.

Historically, the isolation of goat habitat in Alberta's narrow belt of mountains protected goats from human disturbance. These habitats are now becoming accessible via highways, secondary roads, industrial roads, rights-of-way, seismic lines and trails, and increased helicopter use. Exploration for and development of timber, oil, gas, coal and recreational resources often occur close to goats and their critical ranges. In Glacier National Park, Montana, Singer (1975) examined the influence of a highway on mountain goat movements and on their behavior at a mineral lick. He demonstrated a negative effect on highway crossings, although goats did become habituated to human activities at a distance across a river. Pedevillano and Wright (1987) found that park visitors did not disturb goats enough to stop them from using licks but did scare goats away from crossing highways.

Joslin (1986) reported that seismic activities did not result in abandonment of home ranges by mountain goats in Montana, but these activities did coincide with a decline in adult female numbers, kid numbers and productivity in one population. She suggested that stress induced by this industrial activity was cumulative over several years, resulting in reduced productivity. In British Columbia, mountain goats shifted their distribution 1 km - 3 km when subjected to drilling disturbances fully visible from escape terrain, but they returned when the disturbance was removed (Foster and Rahs 1981, 1985). Sopuck (1985) indicated that coal mining operations in the northeastern British Columbia appeared to have displaced mountain goats from areas within 1.5 km of the mine.

One of the components of seismic disturbance is helicopter activity. Helicopters are also increasingly used by the tourism industry to reach remote areas. Côté (1996) found that goats were disturbed by 58 percent of helicopter flights, especially when the helicopters were within 500 m of the herd. Côté recommended that flights within 2 km of goat range be restricted.

In Alberta, about one million people live within sight of mountains and focus much of their recreational activity on the area. Facilitated by abundant access, many recreational developments and activities attract growing numbers of people into the mountain area, increasing the chances of human interaction with goats. Human disturbance and harassment of goats in Alberta is a potentially significant limiting factor warranting increased attention in the future.

2.1.8.4 *Accidents*

Many reports mention carcasses of goats found at the bottom of cliffs or avalanche chutes, perhaps the victims of falls, snowslides or falling rock (Brandborg 1955, Holroyd 1967, B.L. Smith 1976, Wigal and Coggins 1982, Chadwick 1983, Johnson 1983). Brandborg (1955) found 25 carcasses, nearly half of them at the bases of cliffs, but carcass location does not confirm cause of death. Over 60 percent of 30 carcasses found by Chadwick (1983) were in avalanche debris, and 24 of an additional 26 carcasses reported to him were of goats likely killed by avalanches. Seton (1953 in B.L. Smith 1976) observed five goats fall to their deaths from a ledge on which they were stranded. There is also one report of a goat falling to its death after being spooked by a photographer (Johnson 1983). Goats have often been seen falling as the result of aggressive or rambunctious activities that may or may not have involved the unlucky animal (B.L. Smith 1976). Younger goats may be more prone to such accidents because of their rambunctious and somewhat careless behavior (Chadwick 1983).

Brandborg (1955) thought that snowslides in late winter and early spring caused more accidental deaths than any other natural cause. Most mountain goat ranges are subject to avalanches, and goats often appear oblivious to the hazard, exposing themselves to potential danger by walking out on cornices, wading through deep and unstable accumulations of snow and feeding in avalanche chutes (Brandborg 1955, Holroyd 1967).

Accidents are often identified as the most common cause of natural mortality for mountain goats. However, such findings may overemphasize the relative significance of accidents because they are more easily detected and diagnosed than many other forms of mortality. Although accidental deaths are common, their impact on goat populations remains difficult to evaluate.

2.1.8.5 *Malnutrition*

Limiting factors are often interrelated and many authors have pointed out the role of malnutrition in goat mortality. Wigal and Coggins (1982) suggest that the greatest limiting factor for mountain goats is lack of suitable forage during winter, which increases their susceptibility to predation, parasites, disease and accidents. Malnutrition may also impact production by delaying first breeding, leading to resorption of fetuses and reduced maternal care of newborns. Kids that are born may be stunted and unable to survive their first winter.

In most situations, malnutrition is a winter problem for mountain goats. Mountain goats inhabit relatively barren environments often dominated by winter conditions for most of the year. Vegetation grows for only about three months, and quantity and quality of winter forage may be poor. Winter snows vastly restrict the area used by goats and make much of their potential winter forage unavailable under deep and crusted layers of snow. Many studies suggest that goats are in very poor condition by spring even after rather mild winters (Kerr 1965, Holroyd 1967). Forage supply and malnutrition may be significant limiting factors for young goats in Alberta, but most mortality occurs in late fall prior to such hardships (K.G. Smith et al. 1992, Festa-Bianchet et al. 1994).

There seem to be no descriptions or direct proof of major starvation-caused die-offs of mountain goats, similar to those often found in deer and elk populations. However, starvation losses would not be as obvious with goats because they winter in small groups in inaccessible areas and mortalities would not be detected.

2.1.8.6 *Adverse Weather*

Summer precipitation and temperature also affect the quantity and quality of forage on goat ranges. Thus, weather affects the nutritional condition of goats and their ability to avoid a variety of decimating factors, and to survive and reproduce. The effects of weather can also be more direct. Several authors have suggested that cold, wet weather, common in high country around parturition, could lead to hypothermia and death of neonatal goats (Brandborg 1955, Chadwick 1983, Johnson 1983).

Studies outside of Alberta have found a negative correlation between 1 May snow depth and kid to older animal ratios in Colorado (Adams and Bailey 1982) and a positive correlation of reproductive rates with the total winter precipitation 1.5 years before birth and a similarly high correlation between reproductive rates and April snow depth 13 months before birth in Washington State (Stevens 1983). Hebert and Langin (1982) documented declines of 82 and 92 percent, respectively, in two herds following a severe winter in 1978-1979 in coastal British Columbia. Rideout (1974) found higher kid and yearling mortality during a severe winter (73 percent and 59 percent respectively) than during a mild one (27 percent and 2 percent respectively; see also Chadwick 1983).

Less severe winters may be the reason for higher kid to adult female ratios in the United States (0.73 in Washington, Anderson 1940; 0.22-0.79 in Idaho, Brandborg 1955; 0.77-0.84 in Montana, Rideout 1974; 0.86 in the Black Hills of South Dakota, in Rideout 1978). These higher kid to adult female ratios in the United States may also be due to a lack of predators or characteristics associated with newly introduced herds.

There is little evidence to suggest that weather severity significantly influences goat populations in Alberta (K.G. Smith 1988). Findings on Caw Ridge suggest that most of the mortality of young goats occurs before winter (Festa-Bianchet et al. 1994). However, Bailey (1991) indicates a correlation between pre-breeding snow-pack and subsequent reproductive success.

2.2 HISTORY IN ALBERTA

2.2.1 Numbers

Historical records suggest that there were probably over 140,000 mountain goats in North America in the early 1900s (Wigal and Coggins 1982). There is little historical information on goat numbers in the early days of the Province of Alberta. A federally commissioned big game survey indicated that goats were the most common big game in the Canadian Rocky Mountains, and they occurred in numbers well up into the thousands on Alberta's east slopes (Millar 1916). This early survey suggested that goats avoided the serious declines suffered by bighorn sheep and elk (*Cervus elaphus*) during the late 1800s and early 1900s. The declines of these species have been attributed to a combination of factors, including extensive wildfire; rapid development of the livestock industry; excessive harvest by explorers, developers, settlers and natives; and severe winters (Stelfox 1964, 1971). Except for the severe winters, these factors probably did not seriously affect most goat populations because of their rugged and remote habitats.

Because goat managers had not observed any declines in populations and harvest was relatively low and stable, management of goats until the mid-1960s was minimal. Early managers focused efforts on other game species, and monitoring of goat populations was limited mainly to casual observations, often made while surveying other species from fixed-wing aircraft. Based on limited observations, Stelfox (1961) suggested that mountain goats in the Athabasca Special Area (Willmore) numbered 1800-2000. His estimates are two to five times higher than those made between 1970 and 1990, suggesting a decline after 1961. However, comparisons between these two data sets should be approached with caution because the surveys in the 1970-1990 period were much more intensive and extensive.

By the late 1960s, there were concerns about reduced goat numbers, especially in southern Alberta. Several goat populations were inventoried and their very low numbers confirmed (Collins 1969, Jamieson 1969). In the Calgary region, only two areas south of the Bow River maintained goats, and the populations totaled only about 25 animals. Between the Bow and Athabasca Rivers, there were scattered populations, mainly in the most remote areas such as the Ghost and Siffleur Wilderness Areas. Only in the large and remote Willmore Wilderness Park, north of Jasper National Park, were numbers relatively high. Although no census data from the late 1960s exist, subsequent surveys suggest that the Willmore area probably contained 500 goats at that time.

The general goat hunting season was closed in 1970, and monitoring efforts and detailed studies were initiated to quantify and confirm the status of the goat populations in Alberta.

Evaluation of what had happened and determination of the cause of the decline were priority objectives. Extensive goat studies in the 1970s and 1980s showed that herds in many areas of North America had declined similarly. Goat managers everywhere, all without adequate understanding of goat dynamics and without adequate monitoring activity, had failed to detect the problem (Phelps et al. 1975, Kuck 1977, Jamieson 1978, C.A. Smith 1984).

In 1972, a more restrictive hunting season was initiated in Alberta, and goat populations were more closely monitored (Hall and Bibaud 1978, Youds et al. 1980, K.G. Smith 1988). Goats were transplanted to Shunda Mountain, the Highwood Range, the Livingstone Range, Nihahi Ridge and Barnaby Ridge in an effort to repopulate historical ranges (Jorgenson and Quinlan 1996, K.G. Smith et al. 1996). Population surveys occurred at irregular frequencies and were not always consistent in their geographic coverage, so it is difficult to analyze the decline in goat numbers. However, some goat populations continued to decline in the early 1980s despite restrictive hunting strategies, so the goat hunt was completely closed in Alberta in 1988 to provide time to study goats and allow the populations to recover from earlier declines in their numbers.

2.2.2 Distribution

The historical range of mountain goats once extended along the Rockies from southeastern Alaska to central Idaho and western Montana (Wigal and Coggins 1982). In Alberta, mountain goats occurred in the narrow strip of mountainous terrain along the British Columbia boundary (Figure 1). Their distribution within this general area would always have been discontinuous, as goats are restricted to small patches of suitable habitat. South of the Athabasca River, goats were nearly eliminated from much of the area by the late 1960s. By 1977, goats inhabited about 70 percent of their historic range (Hall 1977), with perhaps 50 percent of the provincial population in Willmore Wilderness Park (see Figure 1).

2.2.3 Transplants

Goat transplant activity started in Alberta in 1924 when Banff National Park sent four goats to British Columbia and six goats to South Dakota (Table 6). In the 1960s, wildlife managers realized that depressed populations in southern Alberta were not recovering, and transplants were considered to supplement existing populations and repopulate historic ranges. Gates (1972) took the first step toward a transplant program by identifying and prioritizing potential transplant release sites. He also did preliminary vegetation sampling at some of the candidate sites. Ross (1992) also assessed the priorities for goat transplants in Alberta.

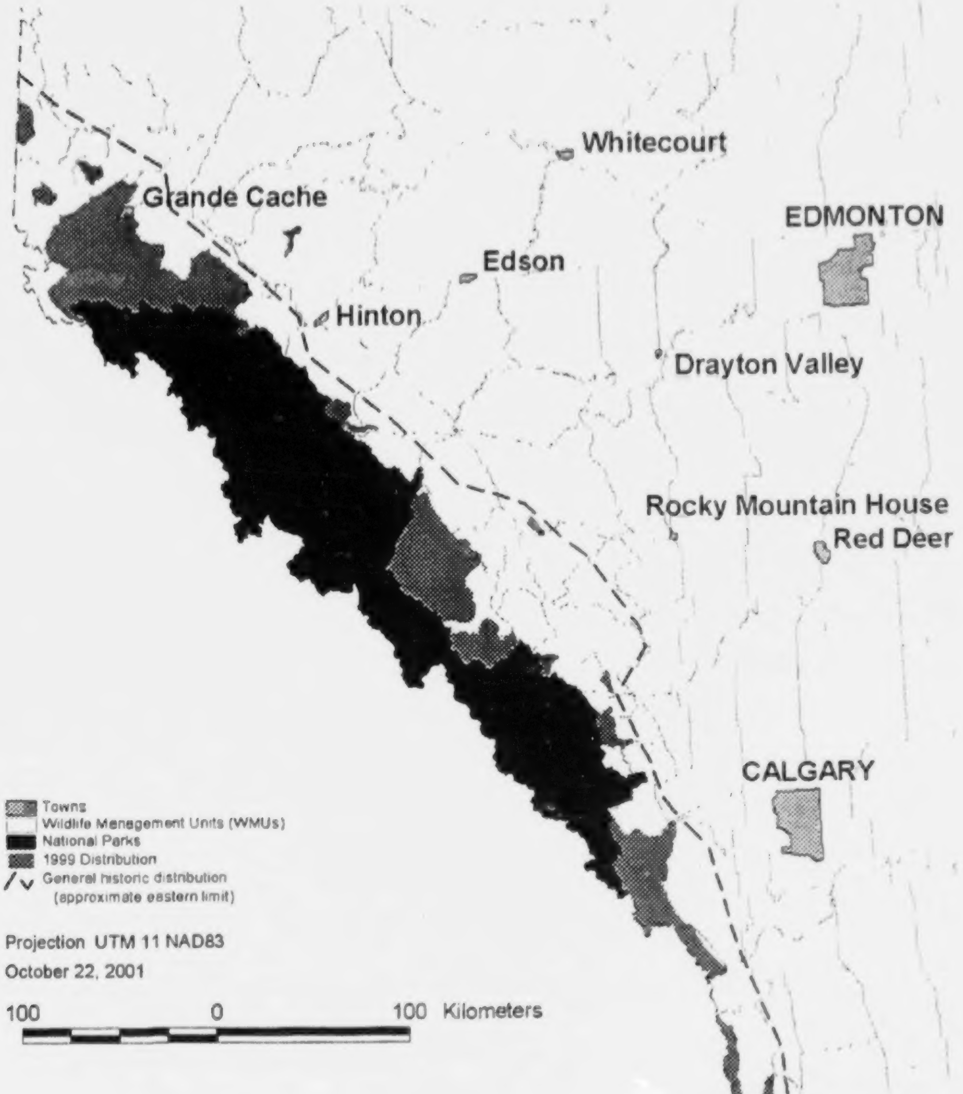

Whitecourt
Grande Cache
EDMONTON
Edson
Hinton
Drayton Valley
Rocky Mountain House
Red Deer
CALGARY
Pincher Creek
Towns
Wildlife Management Units (WMUs)
National Parks
1999 Distribution
General historic distribution (approximate eastern limit)
Projection UTM 11 NAD83
October 22, 2001
100
0
100 Kilometers

Figure 1. Distribution of mountain goats outside the national parks in Alberta.

Table 6. Mountain goat transplants in Alberta, 1924-1995 (K.G. Smith et al. 1996).

Year	Number of Goats	Origin	Destination	Reference
1924	4	Banff National Park	Shaw Creek Game Res., B.C.	Spalding 1993
1924	6	Banff National Park	Black Hills, S. Dakota	Richardson 1971
1972	7	Goat Cliffs	Shunda Mountain	Quaedvleig et al. 1973
1986	2	Caw Ridge	Picklejar Lakes	K.G. Smith 1986
1987	9	Caw Ridge	South Livingstone Range	K.G. Smith 1987
1988	2	Caw Ridge	South Livingstone Range	Ross 1992
1992	2	Mount Hamell	South Livingstone Range	Ross 1992
1993	21	Cayoosh Range, B.C.	Picklejar Lakes	Jorgenson & Quinlan 1996
1993	1	Cayoosh Range, B.C.	South Livingstone Range	Jorgenson & Quinlan 1996
1993	4	White River, B.C.	South Livingstone Range	Jorgenson & Quinlan 1996
1994	6	White River, B.C.	South Livingstone Range	Jorgenson & Quinlan 1996
1995	10	Klingzut, B.C.	Trap Creek	Jorgenson & Quinlan 1996
1995	10	Moose Mountain, B.C.	Trap Creek	Jorgenson & Quinlan 1996
1995	10	Mount Hamell	Nihahi Ridge	Jorgenson & Quinlan 1996
1995	10	Cline River	Nihahi Ridge	Jorgenson & Quinlan 1996
1995	6	White River, B.C.	Barnaby Ridge	Jorgenson & Quinlan 1996
Total	110			

Early transplant efforts in the 1970s and 1980s were inefficient, time consuming and manpower intensive (Jorgenson and Quinlan 1996). Funding became available in 1993 to transplant larger groups of goats with more reliable, but expensive, methods. Table 6 summarizes all the transplants to date, and Appendix 1 provides details on individual goats in the transplants. The following Sections (2.2.3.1 to 2.2.3.5) describe the success of goat transplants in specific areas of Alberta.

2.2.3.1 *Shunda Mountain*

Gates (1972) ranked Shunda Mountain, 15 km southeast of Nordegg, as first priority to receive transplanted goats. Goats had been regularly seen on the range by outdoorsmen in the 1950s, but increased access allowed for over-harvest of the goat population (Gates 1972). The range appeared to provide good goat habitat with adequate winter range, and the small area would allow managers to easily assess the success of the transplant program.

The initial effort to replenish the historic range occurred in 1972 when 7 goats (2 males, 5 females) from the Grande Mountain/Goat Cliffs area near Grande Cache were released on Shunda Mountain. The 4 nannies that remained in the release area (1 left the area via the North Saskatchewan River valley) were relatively old and probably contributed minimally to reproduction in the new area before dying. Kid production was not observed until 3 years following the transplant, and the population did not increase significantly for up to 15 years. The population remained at about 10 animals until 1987 when Smith and Edmonds (1988) observed 18 goats during the summer survey of 1987 (Table 7). The population has apparently declined since.

2.2.3.2 *Highwood Range*

Gates (1972) first identified the Highwood Range in 1972 as a good candidate for goat transplants but considered the area to be a lower priority among his list of candidate release sites. Historically, there was a good-sized herd of goats on the range, but in 1962, a group of hunters slaughtered the entire herd (Gates 1972). The Picklejar Lakes area at the north end of the Highwood Range was the largest area under consideration for goat release; total goat habitat for the area equaled 74.5 km^2 with 4.0 km^2 of snow-free area (Ross 1992). The area contained a higher quality of cliff complexes than any other potential release site, forage was interspersed with escape terrain, and all aspects were well represented. The transplant program for the Highwood Range was initiated in 1986 with the transplant of two nannies from Caw Ridge to the area. Although goats had not been seen in the Picklejar area for some time, there was still a remnant herd, as 12-15 goats were reported in the area in 1986-1987 (Ross 1992). However, it appeared the area could support a lot more goats. The two nannies released in 1986 separated after

Table 7. Mountain goats observed on Shunda Mountain, 1972-1999.

Year	Total	Adults	Yearlings	Kids	Unclassified
1972[a]	8	8	0	0	0
1973	5	5	0	0	0
1974	7	7	0	0	0
1975	5	3	0	2	0
1976	1	1	0	0	0
1977	12	6	3	3	0
1978	3	3	0	0	0
1979[b]	9	4	2	3	0
1980[b]	10	7	2	1	0
1982	9	6	0	3	0
1987	18	10	2	6	0
1990	17	12	3	2	0
1992	12	8	4	0	0
1999	11	9	1	1	0

[a] 1 resident and 7 transplanted animals.

[b] Minimum population from combination of ground and aerial observations.

release; one was last observed just west of the confluence of Storm and Mist Creeks, the other in Junction Creek. In 1992, one of the released nannies was observed with twins, but population growth had not been documented in the Picklejar herd up to 1992 (Ross 1992). The 1986 Picklejar area transplant is an example of limited success due to the introduction of an inadequate number of goats (Ross 1992).

Ross (1992) ranked the Highwood Range as the second priority for Alberta's transplant program. In 1993 and 1995, additional transplants were made to the Highwood Range. Because of the large area of the range, two different release sites were chosen. In the first year, 21 goats (6 males, 15 females) were transplanted from the Cayoosh Range near Lillooet, B.C., to the Picklejar Lakes area (Jorgenson and Quinlan 1996, K.G. Smith et al. 1996). In 1995, 20 more goats (8 males, 12 females) were transplanted from Klingzut, B.C., and Moose Mountain, B.C., to the Trap Creek area. Eleven of the goats received radio collars and were relocated at irregular intervals. Of the 11 radio-collared goats, 9 are known to have dispersed off the Highwood Range and five mortalities have been documented (one grizzly bear predation, one accidental fall, and three unknown causes, Appendix 1). As of October 1996, only four kids had been observed with radio-collared nannies (Jorgenson and Quinlan 1996).

2.2.3.3 *Livingstone Range*

Gates (1972) discussed the Livingstone Range as a potential goat release site but concluded it was more suitable for sheep than goats. However, the south Livingstone Range had about 34.3 km^2 of potential goat habitat with 2.3 km^2 of snow-free area (Ross 1992). Forage production on the range appeared substantial, and escape terrain was always nearby due to the narrowness of the ridge. An additional benefit was that a road provided access to the tree line, and therefore, helicopter support was not needed to release goats.

The first efforts to repopulate the Livingstone Range were in 1987 and 1988 when 11 goats (5 males, 6 females) were transplanted from Caw Ridge (Table 8). Three of the goats received radio collars and were relocated at irregular intervals. One of the radio-collared nannies was found dead in 1992 and the 2 other radio-collared goats (1 male, 1 female) dispersed to the Continental Divide (Ross 1992). Between 1987 and 1991, 10 kids were observed on the Range.

The transplant program for the Livingstone Range continued in 1992 when Ross (1992) ranked the potential release site as number one in all of Alberta. In the first year, 2 nannies were transplanted from Mount Hamell. In 1993, 1 nanny from Lillooet, B.C., and 4 goats (1 male, 3 females) from White River, B.C., were released. The last transplant to the Livingstone Range was in 1994 with 6 additional goats (1 male, 5 females) from White River, B.C. Ten of the 13 goats

Table 8. Mountain goats surveyed on the Livingstone Range, 1987-1999 (Ross 1992, Jorgenson and Quinlan 1996).

Year	Number Released		Number of Goats Observed During Surveys					
	Males	Females	Billies	Nannies	Adults	Yearlings	Kids	Total
1987	4	5	4	5	9	0	0	9
1988	1	1	1	1	7	0	3	10
1989	0	0	-	4	6	1	2	9
1990	0	0	2	3	5	3	2	10
1991	0	0	2	6	8	1	3	12
1992	0	2	-[a]	4	10	1	1	12
1993	1	4	1	2	3	2	0	5
1994	1	5	1	5	6	-	-	-
1996	0	0	-	-	-	-	-	20

[a] The dash means data not available.

transplanted between 1992 and 1994 received radio collars and were located every three months starting in 1993 (Quinlan pers. comm.). Out of the 10 radio-collared goats, 3 dispersed 16 km through a forested landscape to Crowsnest Mountain, and 4 others were found dead (1 illegally shot, 1 capture myopathy, and 2 unknown causes, Appendix 1). As of the fall of 1999, 11 kids (possibly 14) had been produced by the 8 radio-collared nannies (Appendix 1). It appears that kid production/survival has been relatively low since goats were released, but a productive herd has been established on this historic goat range.

2.2.3.4 *Nihahi Ridge*

Ross (1992) ranked Nihahi Ridge as third priority in his list of potential goat transplant sites. The ridge is contiguous with Compression Ridge, and together they contain 23.5 km^2 of potential goat habitat of which 3.2 km^2 is snow-free (Ross 1992). The ridge appeared to have good forage production and was historic range for goats in the 1950s. Furthermore, the ridge was not isolated from other ranges, which would allow genetic exchange over time. One of the major benefits of the ridge was that it had great potential as a roadside public viewing site if transplanted goats regularly used the east side of the ridge. In 1995, 20 goats were transplanted to the ridge from Cline River and Mount Hamell, Alberta. Ten goats (2 males, 8 females) were released on Nihahi Ridge and another 10 (1 male, 9 females) were released on the nearby Compression Ridge. Eight of the 20 goats received radio collars, and all 8 dispersed out of the target area (Jorgenson 1996). Only 2 kids were produced the next summer by 6 of the radio-collared nannies (the status of the seventh radio-collared nanny was unknown, Jorgenson and Quinlan1996). All 8 of the radio-collared goats survived the first year following transplant (Jorgenson and Quinlan 1996).

2.2.3.5 *Barnaby Ridge*

Gates (1972) identified Barnaby Ridge as an excellent candidate site for goat transplants and ranked it second only to Shunda Mountain. The ridge consisted of 22.3 km^2 of potential goat habitat with 2.1 km^2 of the ridge snow-free (Ross 1992). A few goats were regularly seen on the ridge, and the south end of the ridge was contiguous with the Continental Divide. Gates (1972) conducted a vegetation inventory in the area and concluded that species diversity and productivity were good, and forage was well interspersed with escape terrain.

Ross (1992) later confirmed the ridge's potential and indicated that its continuity with the Continental Divide would allow for emigration of transplanted goats if the ridge was unsuitable goat habitat. Six goats (one male, five females) were transplanted to Barnaby Ridge in 1995 from White River, B.C. The transplant resulted in a wide dispersal of four out of five radio-collared goats, and all were found dead within three years (Appendix 1). One of the radio collars (on a female) was faulty and stopped transmitting shortly after release. Visual sightings during relocation flights confirmed that there was no kid production by the transplanted nannies (J. Clark pers. comm.).

2.2.4 Hunting

2.2.4.1 *Prior to 1970*

Appendix 2 provides a summary of mountain goat hunting seasons in Alberta from 1907 to 1987. The goat hunting season has been closed since 1988. The first legislated hunting season for mountain goats in Alberta began in 1909. It was an either-sex season with a bag limit of two and no age or size restriction. The entire province was open. Consistent with low hunter numbers, low interest and limited hunting pressure in remote goat ranges, seasons remained simple and essentially the same for the first 40 years, opening the beginning of September, closing either the middle or end of October, and providing a season of 37-53 days. Other than the bag limit, which was either one or two, the only added restriction during this period was a provision, introduced in 1921, defining legal goats for hunting as at least one year old or with horns at least 4 inches (10 cm) long. This restriction was removed in 1950 and reinstated in the early 1970s, and remained in effect until 1987, after which goat seasons were closed throughout the province. The bag limit was two goats until 1923 when it dropped to one for the next 12 years, presumably in response to perceived differences in goat or hunter numbers. From 1935 to 1938 the limit was again raised to two goats, but since 1939 it has remained at one.

Season manipulation became more substantive in 1949 when the open period was restricted to 27 days between 15 September and 15 October. In 1957, separate seasons were specified for individual areas of the province (Appendix 2). The Canmore Corridor area was closed to rifle hunting and became an archery-only area the following year. From 1958 to 1963, there were generally two different seasons in open parts of the province; two months in the less accessible areas where populations were considered strong and six to seven weeks where populations were thought to be more accessible, more vulnerable or less vigorous. The shorter season usually applied to the area between the Bow and Brazeau Rivers and east of Special Hunting Areas 2 and 3, now known as the Siffleur and Whitegoat Wilderness Areas. From 1964 to 1967, a single two-month season was again declared for all goat ranges with an additional month (78 days in total) in 1966 for Wildlife Management Units (WMUs) 440-442 in Willmore Wilderness Park.

In 1966, goat hunting was closed around the new mining town of Grande Cache in WMU 444. The area immediately adjacent to the development has never been reopened. This closing marked the beginning of a new, conservative philosophy of goat management that followed the first detailed scientific study of mountain goats in Alberta (Kerr 1965). As the Wildlife Branch accumulated more detailed data, much of it documenting the decimation of many goat herds, hunting opportunity was severely reduced in much of the province. In 1968, seasons were closed south of the Kananaskis area and limited to 13 days in the area from there north to the Athabasca River. Only the archery zone (WMU 410) and Willmore area (WMUs 440 and 442) maintained the two-month season. In 1969, all seasons south of the Athabasca River were closed, and goat hunting was limited to a 28-day season in specified parts of the Willmore. The 1969 season was the last season in which an unlimited number of general licences were available, and 59 were purchased. The season was closed throughout Alberta in 1970 and 1971.

Appendix 3 provides a summary of harvests from 1950 to 1987. During the period 1950 to 1967, the harvest averaged 179 (range 85-258) goats per year. There was a marked decline in harvest in 1968 and 1969. It took only two years for Alberta to change from a two-month general season (in 1967) to a complete closure, once the status of the goat population was recognized. The speedy reaction was important in protecting and maintaining remnant herds.

2.2.4.2 *After 1970*

After two years of closure, goat hunting resumed in 1972 (Appendix 2). However, hunting was on a limited draw basis (75 licences) during the first two weeks of October and only where sufficient populations remained in parts of the Willmore area (a portion of WMU 442). Licence numbers in the Willmore were reduced to 50 in 1973. Figure 2 summarizes the number of hunting licences and the harvest, and also provides a summary of the goat population index in Willmore from 1973 to 1987. Beginning in 1974, in order to distribute the harvest more evenly, the open area was divided into six designated Goat Hunting Areas (GHAs; Figure 3), with limited numbers of licences issued for each. Only recently surveyed herds were hunted, and the permit numbers varied slightly but were set to limit the harvest to a maximum of 10 percent of the spring population. The resulting harvest (Appendix 3) averaged about 5 percent of the spring population (Hall and Bibaud 1978).

The sex ratio of harvested goats in the Willmore area varied annually, but the average was biased towards males at 58 percent (Table 9). The proportion of males in the harvest was higher in southern Alberta (Figure 4) where males made up 76 percent of the harvest during 1986 and 1987 (n=21, GHAs M, O, Q, R). This information suggests that hunters can and do selectively harvest males because males make up only one third of the adults (Table 2). The ages of mountain goats

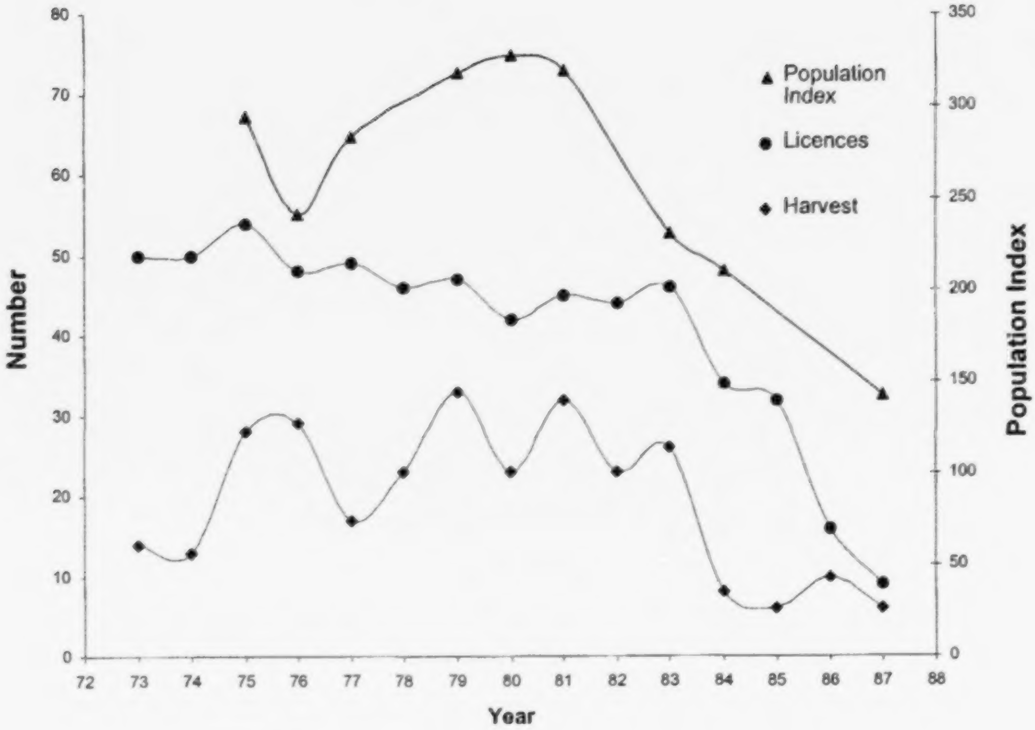


Figure 2. The number of hunting licences allowed and the number of mountain goats harvested in Willmore Wilderness Park from 1973-1987 (K.G. Smith 1988). A population index is also included for five consistently surveyed herds in Willmore (Llama-Turret, Monoghan, Moosehorn, Persimmon North and Triangle).

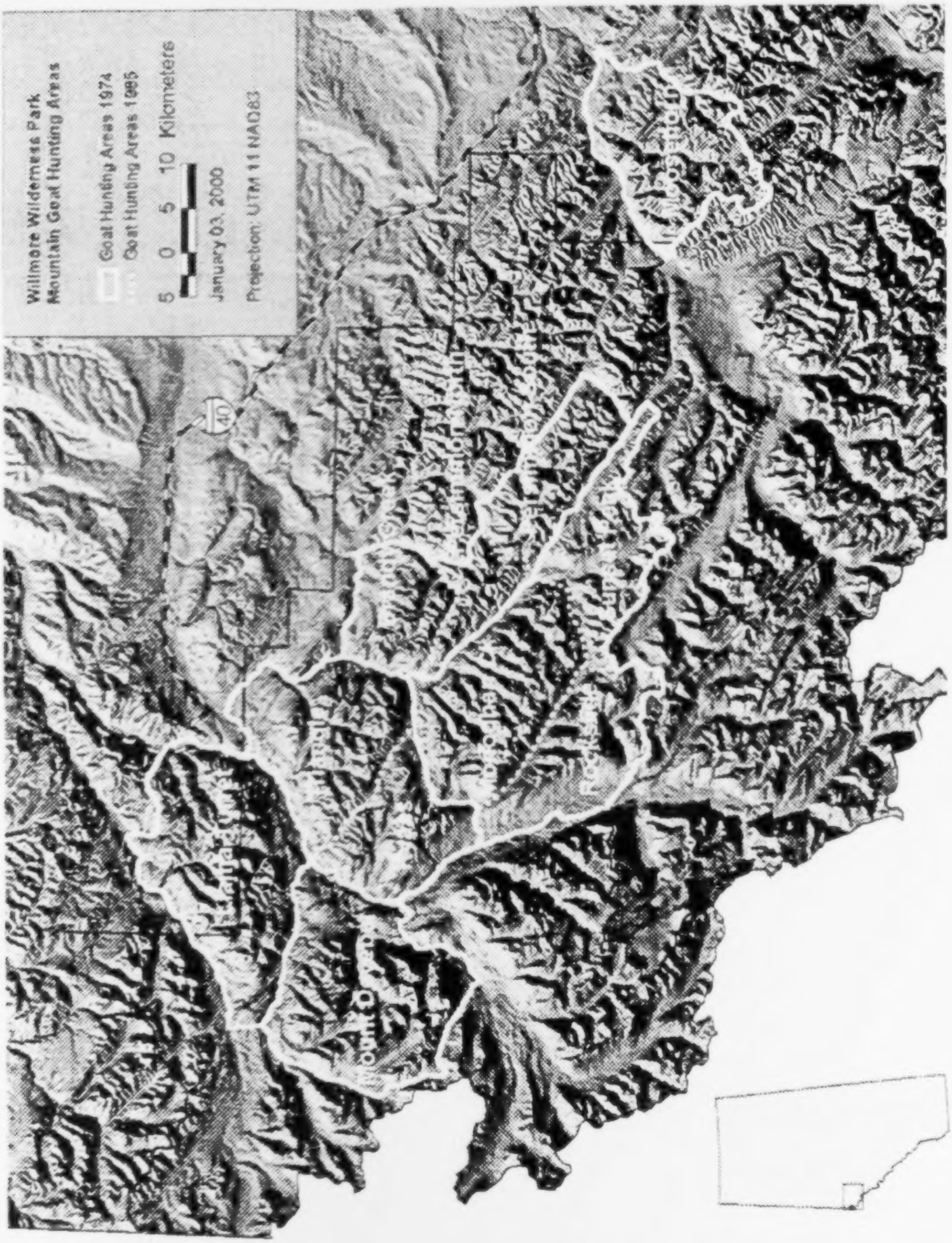

Willmore Wilderness Park
Mountain Goat Hunting Areas
Goat Hunting Areas 1974
Goat Hunting Areas 1985
5 0 5 10 Kilometers
January 03, 2000
Projection: UTM 11 NAD83
40

Figure 3. Six mountain Goat Hunting Areas (GHAs) established in the Willmore area in 1974 were further subdivided into 11 GHAs in 1985.

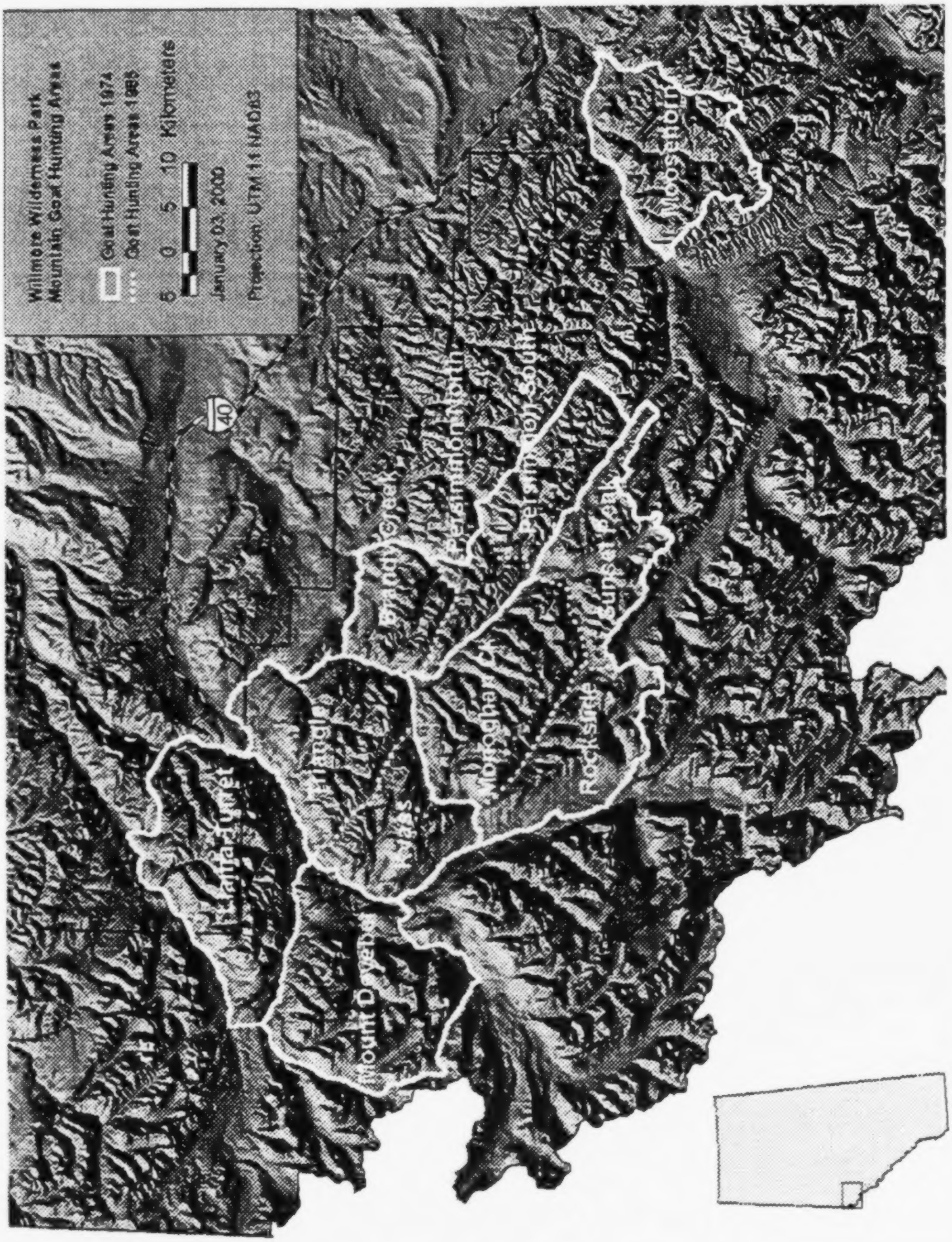

Willmore Wilderness Park
Mountain Goat Hunting Areas
Goat Hunting Areas 1974
Goat Hunting Areas 1985
5 0 5 10 Kilometers
January 03, 2000
Projection: UTM 11 NAD83
40
Moosehorn
Persimmon North
Persimmon South
Berland Creek
Sunset Peak
Monaghan
Rockslide
Triangle
Kvass
Mount Deveber

Figure 3. Six mountain Goat Hunting Areas (GHAs) established in the Willmore area in 1974 were further subdivided into 11 GHAs in 1985.

Table 9. Sex ratio of annual mountain goat harvests in Willmore Wilderness Park, 1974-1987 (K.G. Smith 1988).

Year	Males	Females	Total
1974	7	5	12
1975	10	18	28
1976	17	12	29
1977	5	11	16
1978	12	10	22
1979	28	5	33
1980	7	16	23
1981	21	11	32
1982	14	9	23
1983	15	11	26
1984	5	3	8
1985	6	0	6
1986	6	4	10
1987	5	1	6
Total	164 (58%)	120 (42%)	284 (100%)

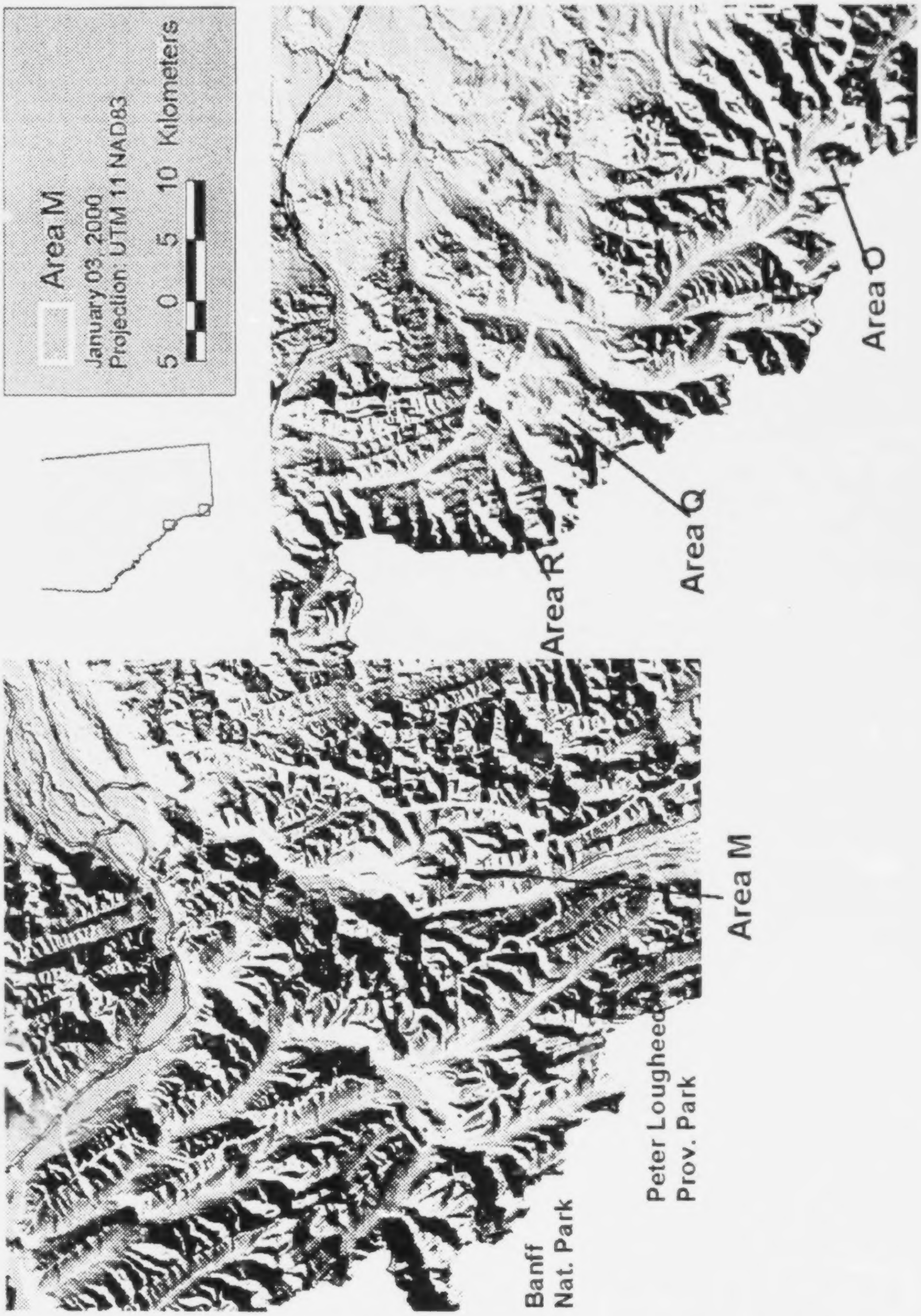

Area M
January 03, 2000
Projection: UTM 11 NAD83
5 0 5 10 Kilometers
Area R
Area Q
Area O
Area M
Peter Lougheed Prov. Park
Banff Nat. Park

Figure 4. Goat Hunting Areas (M, O, Q and R) established in southern Alberta in 1986.

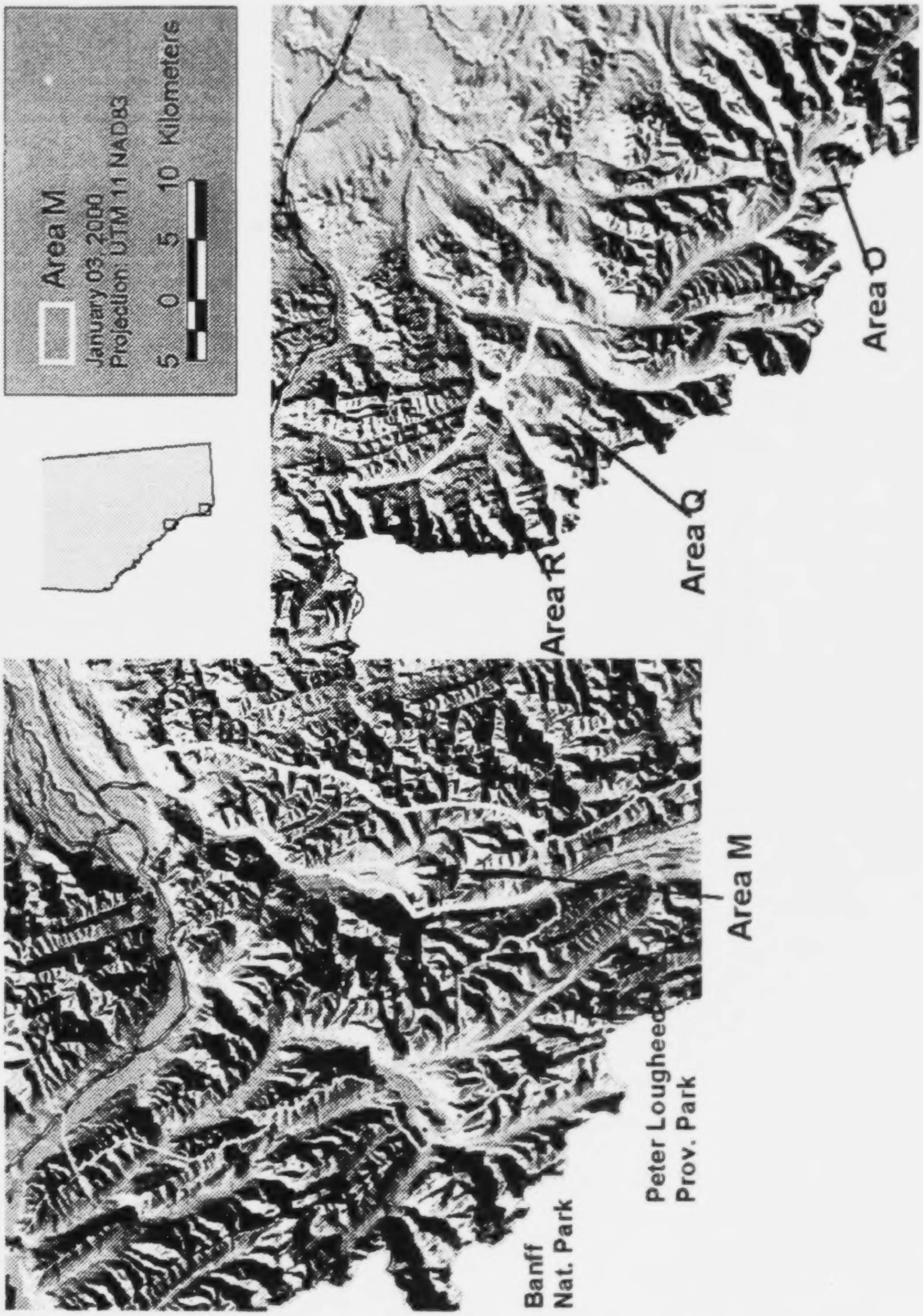

Area M
January 03, 2000
Projection: UTM 11 NAD83
5 0 5 10 Kilometers
Area R
Area Q
Area O
Area M
Banff
Nat. Park
Peter Lougheed
Prov. Park

Figure 4. Goat Hunting Areas (M, O, Q and R) established in southern Alberta in 1986.

harvested between 1977 and 1986 in the Willmore area ranged from 1.5 to 13.5 years for both sexes, and ranged from 4-6.5 years for males and from 4.6-8.5 years for females (Table 10).

Goat numbers appeared to expand under this hunting regime until the early 1980s when they began to decline (Figure 2). In 1984, licence numbers were reduced to 32, and in 1985, the 6 areas open to hunting were further divided into 11 smaller units (Figure 3, Smith and Taggart 1984). In 1986, licence numbers were reduced to 16 and only 9 of the 11 areas were open. In 1987, only 9 licences were issued, and in 1988, the goat season in the Willmore area was closed. Unlike the closures in 1970 and 1971, the 1988 closure was supported by better inventory data, which indicated the population was continuing to decline (K.G. Smith 1988; Figure 2).

Although there were seasons in the Willmore area, goat hunting had remained closed in the rest of Alberta from 1972 to 1986. Population monitoring indicated that goat herds not being hunted, both in the Willmore area (K.G. Smith 1988) and south of the Bow River, had been maintaining themselves or increasing steadily during the 1970s and 1980s (Cook 1980, Kansas and Pall 1983, Smith and Edmonds 1988). Therefore, seasons, with limited numbers of licences, were opened in specific parts of the Kananaskis and Castle River areas in 1986 (Figure 4), the first goat hunting season in southern Alberta since 1968. When aerial population surveys found lower goat numbers after the 1986 and 1987 seasons in both the Willmore and southern Alberta areas, all seasons were closed in 1988 to allow for a complete review of the mountain goat management program in Alberta and to prepare a management plan.

2.2.4.3 *Demand, Effort and Success*

Following the hunting closure in the early 1970s, a limited licence season was initiated in 1972 in the Willmore area. There was a general increase in applications through to 1985 (Appendix 2). In 1986, the opening of limited licence seasons in specific parts of the Kananaskis and Castle River areas of southern Alberta resulted in a four-fold increase in applications provincially, as southern Albertans responded to the opportunity to hunt mountain goats closer to home. Applications dropped by 738 (38 percent) in 1987, probably because of the low success rate in the draw, a 54 percent reduction in available permits, and the closure of two areas in the Willmore. However, considerable interest and demand were still evident.

The only available measure of mountain goat hunter effort comes from 1986 and 1987 telephone harvest questionnaires. The number of hunter-days required/animal harvested ranged from one day in two of the more accessible GHAs in 1987 to 20 days in one of the least accessible areas in 1986 (Table 11). The success rate in west-central Alberta averaged about 50 percent, but

Table 10. Mean ages of mountain goats harvested in Willmore Wilderness Park, 1977-1986 (K.G. Smith 1988).

Year	Males			Females		
	Age	Range	n	Age	Range	N
1977	6.3	3.5-8.5	5	4.6	1.5-8.5	8
1979[a]	4.8	1.5-9.5	27	6.3	2.5-9.5	5
1980	6.5	3.5-12.5	7	5.3	2.5- 7.5	13
1981	5.1	1.5-13.5	19	5.7	1.5-10.5	10
1982	4.7	2.5-9.5	10	7.0	4.5-12.5	6
1983	5.7	1.5-13.5	11	5.1	1.5-13.5	5
1984	4.0	2.5-4.5	4	6.2	3.5- 9.5	3
1986[a]	5.5	3.5-7.5	4	8.5	8.5- 8.5	3

[a] There were no sex specific data for 1978 or 1985.

Table 11. Effort and success by Alberta mountain goat hunters in 1986 and 1987.

Hunting Area	1986				1987			
	Total Hunter Days	Mean Days/ Hunter	Mean Days/ Goat	Success (%)	Total Hunter Days	Mean Days/ Hunter	Mean Days/ Goat	Success (%)
B	22	4.3	10.8	40	8	4.0	8.0	50
D	8	4.0	-	0	-	-	-	-
E	12	12.0	12.0	100	-	-	-	-
F	18	6.0	6.0	100	-	-	-	100
G	-[b]	-	-	100	8	8.0	8.0	100
H	28	7.0	14.0	50	1	1.0	1.0	50
I	20	6.7	20.0	33	6	3.0	3.0	100
M[a]	14	2.4	2.4	100	-	-	-	100
O[a]	18	6.0	6.0	100	-	-	-	100
Q[a]	4	2.0	2.0	100	12	6.0	6.0	100
R[a]	38	12.5	12.5	100	2	1.0	1.0	100
All	n/a[c]	n/a	n/a	73	n/a	n/a	n/a	81

[a] Southern Alberta hunting areas.

[b] The dash means data not available.

[c] Means provincial totals are not possible because data are not complete.

the southern Alberta units boosted the provincial mean to 73 percent in 1986 and 81 percent in 1987 (Table 11). Success rates of 100 percent should be anticipated where herds are easily accessible.

2.3 CURRENT STATUS AND MANAGEMENT IN ALBERTA

2.3.1 Status of Habitat

At present, provincial goat range is subdivided into four Goat Management Areas (GMAs) based on similarities in habitat and management issues, as follows: A - Pincher Creek; B - Kananaskis; C - Bow Valley to the Brazeau River; and D - north of the Brazeau River (Figure 5). Areas A and B are close to a large human population and are highly accessible. Area D is remote with few people and limited access, and area C is intermediate in these characteristics.

General habitat requirements for mountain goats are summarized in Section 2.1.5. Because the size, location, condition and utilization of most seasonal ranges in Alberta are not well known, the status of mountain goat habitat in the province remains uncertain. Habitat used currently by goats is considered to be relatively intact. However, much of this habitat continues to be affected by the development of more access trails and roads. Past increases in access have been identified as the likely cause of over-harvest and extirpation of goats from historic ranges in the 1960s.

Although current habitat remains generally intact, making sure the habitat is available for use (i.e., habitat effectiveness) remains as a significant management challenge because goats are susceptible to human disturbance. Some notable locations where access is being developed on mountain goat range include Mount Hamell, Caw Ridge, Grande Mountain, Goat Cliffs and Pinto Creek. Recreational activities (e.g., hiking, skiing, horseback riding, all-terrain vehicle operation) are also a concern in areas such as Kananaskis Country. Commercial helicopter touring is becoming popular and poses a significant threat to the seclusion of goat habitat.

2.3.2 Status Of Goats

2.3.2.1 *Numbers*

The most recent estimate, based on 1997 to 2000 data, is 1652 mountain goats on provincial lands and 786 in the national parks in Alberta (Table 12). Alberta has about 5 percent of the total number of mountain goats estimated in North America by Wigal and Coggins (1982). Because observers never see all the animals during aerial surveys, the actual number of goats in Alberta will be greater than the numbers observed. Gonzalez-Voyer et al. (2001) found that numbers from aerial surveys average about 70 percent of the actual goat numbers on Caw Ridge, but year to year variation is considerable (this figure was determined by comparing aerial survey data with the known population). This management plan will use observed numbers of goats as the basis for management decisions because the 70 percent likely varies significantly from year to year and among areas.

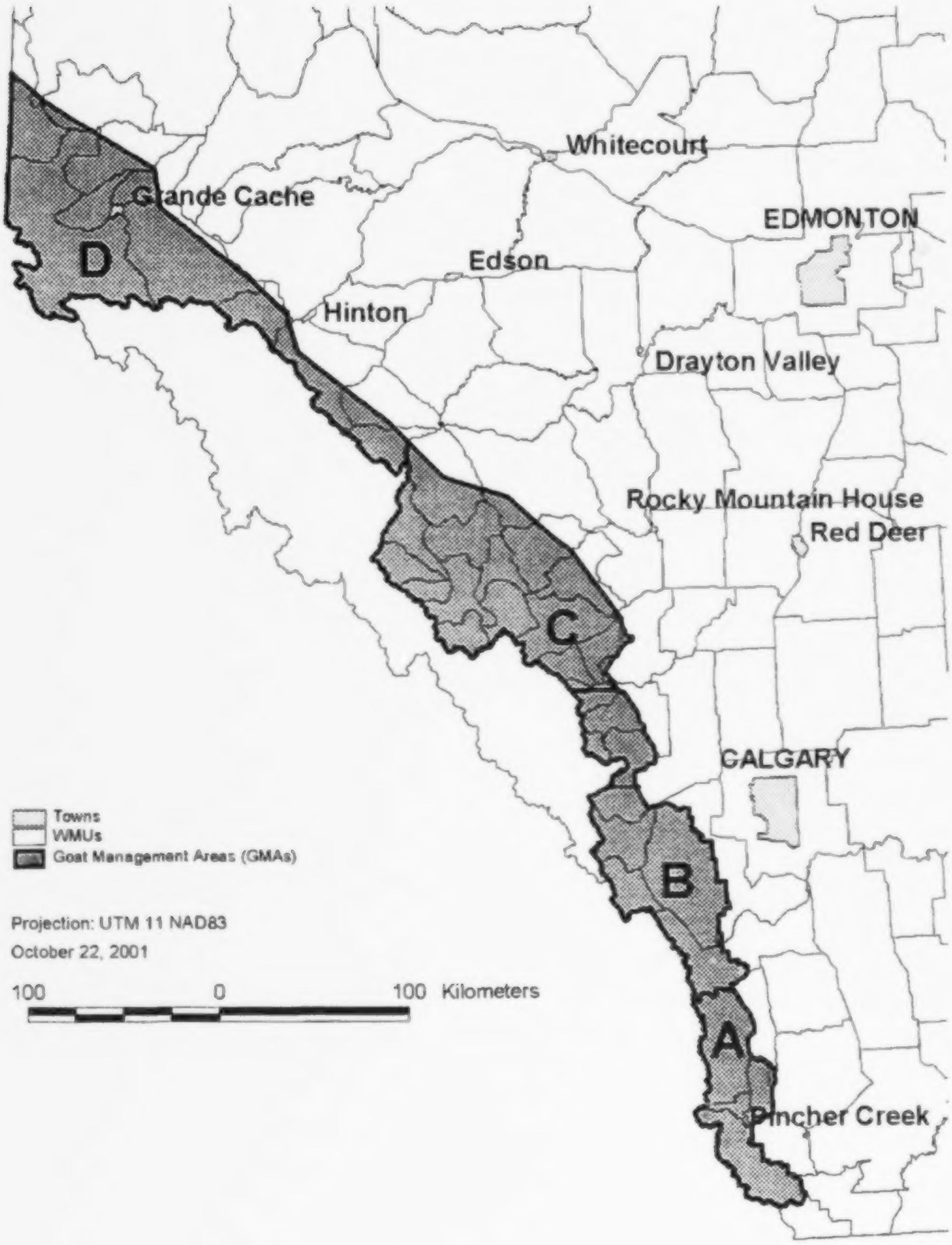

Whitecourt
Grande Cache
EDMONTON
D
Edson
Hinton
Drayton Valley
Rocky Mountain House
Red Deer
C
CALGARY
B
A
Pincher Creek
Towns
WMUs
Goat Management Areas (GMAs)
Projection: UTM 11 NAD83
October 22, 2001
100 0 100 Kilometers

Figure 5. Mountain Goat Management Areas (GMAs) in Alberta.

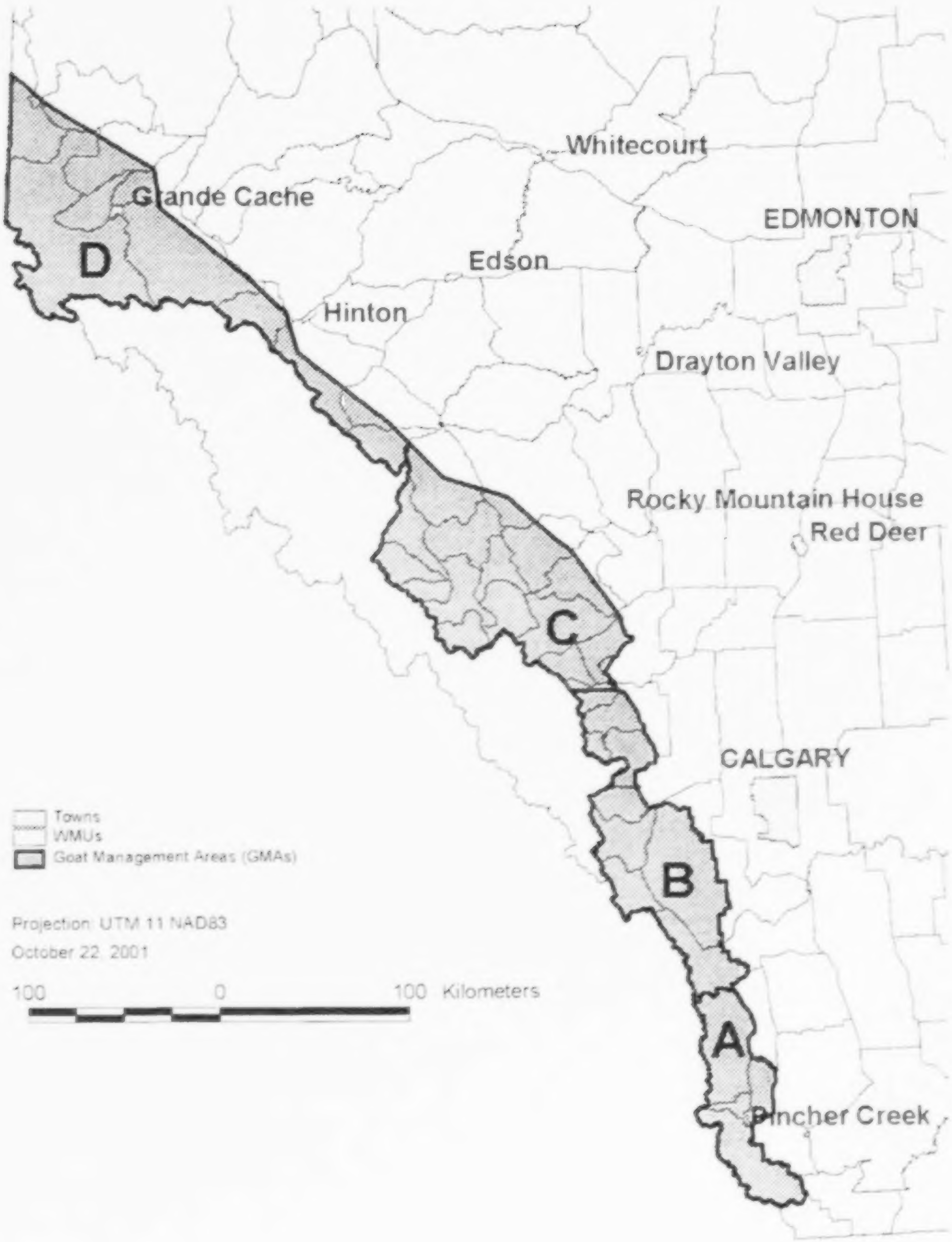

Whitecourt
Grande Cache
EDMONTON
D
Edson
Hinton
Drayton Valley
Rocky Mountain House
Red Deer
C
CALGARY
Towns
WMUs
Goat Management Areas (GMAs)
B
Projection: UTM 11 NAD83
October 22, 2001
100
0
100 Kilometers
A
Pincher Creek

Figure 5. Mountain Goat Management Areas (GMAs) in Alberta.

Table 12. The most recent numbers of mountain goats observed during aerial surveys and/or estimated by wildlife managers in the four Goat Management Areas (GMAs) in Alberta.

GMA[a]	WMU	Area	Observed[b]	Source
A	400	Waterton, Carbondale and Castle	182	Clark 1999
	402	Alberta - B.C. border	34	Clark 1997
	306/402[c]	Livingstone Range	20	Quinlan pers. comm. 2000
	402[c]	Crowsnest Mountain	16	Clark pers. comm. 2000
Total for Goat Management Area A			252	
B	408/648[c]	Area M, Kent Ridge and Opal Range West	114	Jorgenson pers. comm. 2000
	404/406/408[c]	Elk, Fisher, Elbow, Opal and Kananaskis Ranges	156	Jorgenson pers. comm. 2000
	410/412/734[c]	Canmore, Devils Head and Ghost Wilderness Area	75	Jorgenson pers. comm. 2000
Total for Goat Management Area B			345	
C	328	Shunda	12	Allen 1998
	414/416[c]	Burnt Timber Creek-Bruns Ridge	25	Bruns pers. comm. 2000
	417[c]	Wilson Creek	4	Allen pers. comm. 2000
	418[c]	Eagle Creek	10	Bruns pers. comm. 2000
	420[c]	Peters Creek	5	Bruns pers. comm. 2000
	422	South Ram	18	Allen 1998
	426/430/432	First Range and Cline Creek	39	Allen 1998
	428[c]	Kiska Creek	2	Allen pers. comm. 2000
	432	Whitegoat Peaks	45	Allen 1998
	434[c]	Blackstone-Wapiabi	2	Allen pers. comm. 2000
	736	Siffleur Wilderness	31	Allen 1998
	738	White Goat Wilderness	2	K.G. Smith and Edmonds 1988
Total for Goat Management Area C			195	
D	344[c]	Pinto Creek	28	Kranrod pers. comm. 2000
	356[c]	Kakwa-Smoky Confluence	0	Hervieux pers. comm. 2000
	436[c]	Cardinal-Brazeau	5	K.G. Smith pers. comm. 2000
	437[c]	Red Cap Range	0	K.G. Smith pers. comm. 2000
	438	Whitehorse Creek	1	Sorensen and Smith 1999
	439	Moosehorn	10	Sorensen and Smith 1999
	440	Berland-Hoff Range	30	Sorensen and Smith 1999
	440	Daybreak Peak	18	Sorensen and Smith 1999
	440	South Persimmon	62	Sorensen and Smith 1999
	440	North Persimmon	21	Sorensen and Smith 1999
	441	Goat Cliffs-Grande Mountain	72	Sorensen and Smith 1999

Table 12 continued next page

Table 12 continued

GMA[a]	WMU	Area	Observed[b]	Source
D	442	Sunset Peak	23	Sorensen and Smith 1999
	442	Rockslide Creek	11	Sorensen and Smith 1999
	442	Monoghan Creek	58	Sorensen and Smith 1999
	442	Ptarmigan Lake	63	Sorensen and Smith 1999
	442	The Triangle	20	Sorensen and Smith 1999
	442	Mount Deveber	107	Sorensen and Smith 1999
	442	Kvass	2	Sorensen and Smith 1999
	442[c]	Cote/Trench/Bear Creek	12	K.G. Smith pers. comm. 2000
	442[c]	Mount May/Francis Peak/La Creche Mountain	15	Hervieux pers. comm. 2000
	444	Llama/Turret	101	Sorensen and Smith 1999
	444	Mount Hamell	60	Sorensen and Smith 1999
	445[c]	Dinosaur Ridge	10	Hervieux pers. comm. 2000
	445[c]	Narraway Valley	15	Hervieux pers. comm. 2000
	445[c]	Sulphur Mountain	15	Hervieux pers. comm. 2000
	446	Caw Ridge	101	Sorensen and Smith 1999
Total for Goat Management Area D			860	
Total for Provincial Lands			1652	
National Parks		Waterton Lakes National Park	36	Watt pers. comm.,1997 survey
		Banff National Park	500	Hurd and Dibb pers. comm. 2001
		Jasper National Park[c]	250	Mercer pers. comm. 2000
Total for National Parks			786	
ALBERTA TOTAL			2438	

[a] GMAs: A = Prairie Region; B = Bow Region; C = Parkland Region; and D = Northern East Slopes and Northwest Boreal Regions.

[b] The numbers of goats observed during the most recent aerial survey, except [c] (see below).

[c] Not been surveyed recently so numbers represent estimates and are based on observations from the ground, information supplied by others and/or estimates by local wildlife managers.

Note: Many herds are shared with British Columbia or national parks, but the numbers (other than those numbers for the national parks) represent only those goats observed on Alberta provincial lands.

2.3.2.2 *Distribution*

The current distribution of mountain goats in Alberta is illustrated in Figure 1. Historical and anecdotal information suggest that the historic range in Alberta (Figure 1) was much larger. Mountain goats are occasionally seen in forested habitats far from mountainous terrain (e.g., the McLeod River south of Whitecourt). This behavior appears to be restricted to individuals or pairs of the same sex in most instances, as young are almost never produced and herds seldom develop. An exception is the Pinto Creek herd with 28 goats (Kranrod pers. comm.). This herd has inhabited a series of riverine cliffs in the boreal forest some 56 km from the nearest mountain range since at least 1942 (Stelfox and Kerr 1962).

2.3.3 Use

2.3.3.1 *Non-consumptive Use*

No specific information exists on the amount of non-consumptive activities involving mountain goats on provincial lands in Alberta. Goats ranked 11th in the "like-to-see" category and 16th in the "like-to-see-more-of" category in a 1976 random survey of Alberta residents (Phillips et al. 1977). Based on a 1996 survey of Albertans (DuWors et al. 1999), 88.9 percent of Albertans participated in a wide range of nature-related activities. Twenty-four percent of Albertans made trips to participate in outdoor activities in nature; about one-third of these trips were specifically to view wildlife. Nineteen percent of Albertans each averaged 19 days per year viewing wildlife, both at home and during trips.

Albertans living in or spending time in the eastern slopes would focus some of their non-consumptive wildlife-viewing efforts on mountain goats and in mountain goat habitat. Goats would also be of interest to non-resident tourists because they are unique and not present in most of North America. The presence of mountain goats substantially enhances the tourism package, but goat viewing is likely not that significant because of limited accessibility and viewing opportunities for most people. Caw Ridge, White Goat and Siffleur Wilderness Areas, Yamnuska Mountain, Peter Lougheed Provincial Park and the Icefields Parkway south of Jasper (e.g., Mount Kerkeslin) are all listed as potential mountain goat viewing areas in the *Alberta Wildlife Viewing Guide* (Alberta Forestry, Lands and Wildlife 1990).

2.3.3.2 *Consumptive Use*

There has been no consumptive use of goats, other than poaching and native harvest, since 1988, when goat hunting was closed in the province. Because mountain goats are not highly prized for their meat or trophy value, it is unlikely that poaching levels have been significant. Treaty Indians seldom hunt mountain goats in Alberta.

2.3.4 Data Collection Guidelines and Field Management Techniques

2.3.4.1 *Survey Techniques*

Goat Population Areas (GPAs) are WMUs or portions of WMUs that encompass one or more goat herds and individuals that regularly interact with one another. It is important to use standardized methods to inventory GPAs so that data can be compared between years to determine trends and to monitor status relative to management goals and objectives. Mountain goats are inventoried from a helicopter in July when nursery groups frequent open alpine meadows and are most observable. At this time, groups are relatively large, yearlings can be distinguished by experienced observers, and the molt is still a helpful indicator of age and sex classes.

A survey cover sheet is completed each day of a survey (Appendix 4). The cover sheet includes information on flight time, date, weather, pilot, aircraft, survey area, methods and general observations (e.g., "wolves seen in area" or "forage is dry and brown").

Whenever possible, flights are scheduled in early morning (0600-0900) and late evening (1800-2200) when mountain goats are most active and wind is minimal. Maximum activity usually occurs on bright, clear days at least five hours after cloudy periods of rain and inclement weather (Fox 1977), but surveying on bright, cloudless days should be avoided to minimize problems with severe glare and contrast. Although time constraints seldom permit waiting for perfect conditions, poor conditions substantially reduce data quality and must be avoided (C.A. Smith 1984).

A standardized data sheet is used to collect the data (Appendix 5). The inventory crew consists of a pilot, navigator and two primary observers. The primary observers occupy the rear seats in the helicopter and are responsible for continuous visual coverage of each search area (i.e., middle of the slope to ridge top and middle of the slope to timberline below). The right rear observer records all pertinent information on the field data sheets. The navigator occupies the left front seat and ensures all areas are covered. The navigator is also responsible for marking checkpoint locations accurately, recording GPS locations, aiding with herd classifications and observing as time permits (Cook 1985). A GPS location is recorded for each group of goats.

A total census of each survey complex (i.e., Goat Population Area) is attempted, and surveys are done as consistently as possible. Total inventory coverage of each designated mountain complex is attempted by flying each drainage basin in a manner that makes best use of sunlight and minimizes glare. The flight line is located equidistant between timberline and ridge top. When a belt too wide to be effectively searched in one pass is identified, additional passes are made as required. Airspeed ranges from 100 km/h to130 km/h, depending on wind and terrain.

The best method of monitoring the population status of a mountain goat herd is by obtaining total counts (Hebert and Langin 1982). When possible, mountain goats should be classified by experienced observers as adult, yearling or kid. When group sizes are small, goats are classified from the helicopter by the navigator and left rear observer with one counting yearlings and the other counting kids and the total. When yearlings are not distinguishable, the goats would be classified as "kids" and "goats older than kids". When encountering large groups (>15) or goats in hazardous terrain, the helicopter should land, usually less than 1 km away, so observers can classify the goats from the ground, using a 20-45 power spotting scope, (Cook 1985). This technique improves the quality of data and reduces harassment of the goats. Photographs are useful in classifying large groups and verifying numbers after the survey.

Annual surveys can provide an index of kid mortality if the yearling to adult ratio in one year is compared to the previous year's kid to adult ratio. However, such ratios should be interpreted with caution. The distribution of individual herds in the complex and herd composition (e.g., the number of males and sub-adults) may change from year to year so that changes in ratios may not represent kid mortality (C.A. Smith 1984). Gonzalez-Voyer et al. (2001) found that yearlings were sometimes identified as kids during helicopter surveys in Goat Management Area D.

It is important to maintain a survey schedule to determine long-term trends. In the past, survey frequency was generally based on whether or not the mountain goat population was hunted. However, aerial surveys in Goat Management Area D have been designed to give annual coverage of 6 Goat Population Areas (Table 13) in order to maintain continuity of data and provide survival rates for goats between kid and yearling age. The remaining 12 areas in GMA D are surveyed biennially, half of them each year. Further south, the areas are surveyed every three years (Table 13). Figures 6-9 show the boundaries of all the Goat Population Areas in the province that are currently being surveyed.

Table 13. Frequencies of mountain goat surveys in the four Goat Management Areas (GMAs) in Alberta prior to the year 2000.

GMA[a]	Frequency	WMU	Goat Population Area
A	Biennial	306	Livingstone
	Biennial	400	Area O, B and Upper West Castle
	Biennial	400	Area Q and C
	Biennial	400	Area R, D and North End Divide
	Biennial	402	Continental Divide
B	Biennial	408[b]	Area M
	Biennial	648[b]	West Opal Range
	Biennial	408/648[b]	Kent Ridge
C	Biennial	738	White Goat Wilderness
	Biennial	422	South Ram
	Biennial	430	Cline Creek
	Biennial	432	White Goat Peaks
	Triennial	328	Shunda Mountain
	Triennial	432	First Range
	Triennial	736	Siffleur
D	Annual	439	Moosehorn
	Annual	440	Daybreak Peak
	Annual	441	Goat Cliffs-Grande Mountain
	Annual	444	Llama-Turret
	Annual	444	Mount Hamell
	Annual	446	Caw Ridge
	Biennial	438	Whitehorse Creek
	Biennial	440	North Persimmon
	Biennial	440	South Persimmon
	Biennial	440	Berland-Hoff
	Biennial	442	Mount Deveber
	Biennial	442	Kvass
	Biennial	442	The Triangle
	Biennial	442	Monoghan Creek
	Biennial	442	Sunset Peak
	Biennial	442	Rockslide
	Biennial	442	Ptarmigan Lake

[a] GMAs: A = Prairie Region; B = Bow Region; C = Parkland Region; and D = Northern East Slopes and Northwest Boreal Regions.

[b] Not surveyed since 1993.

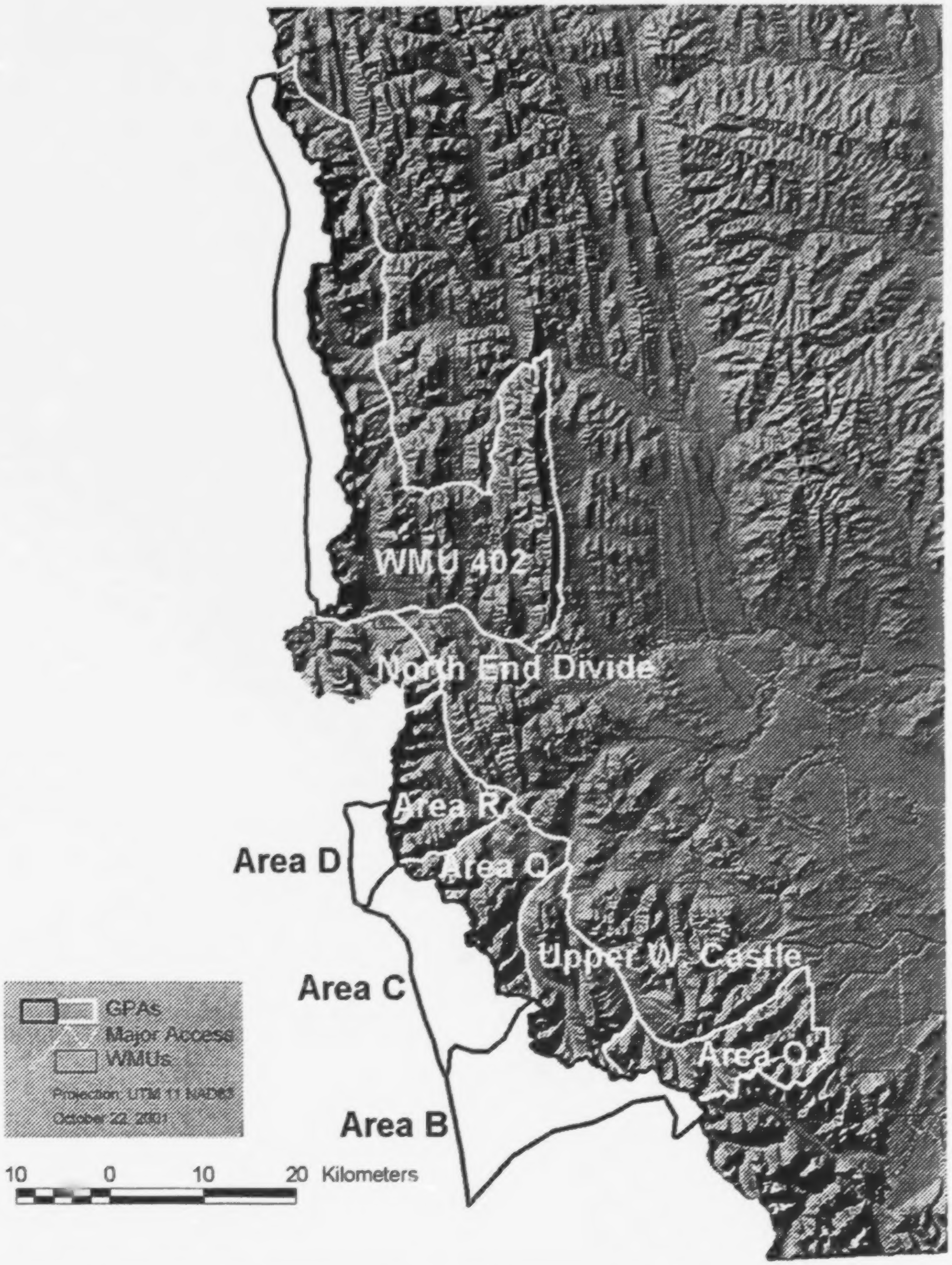
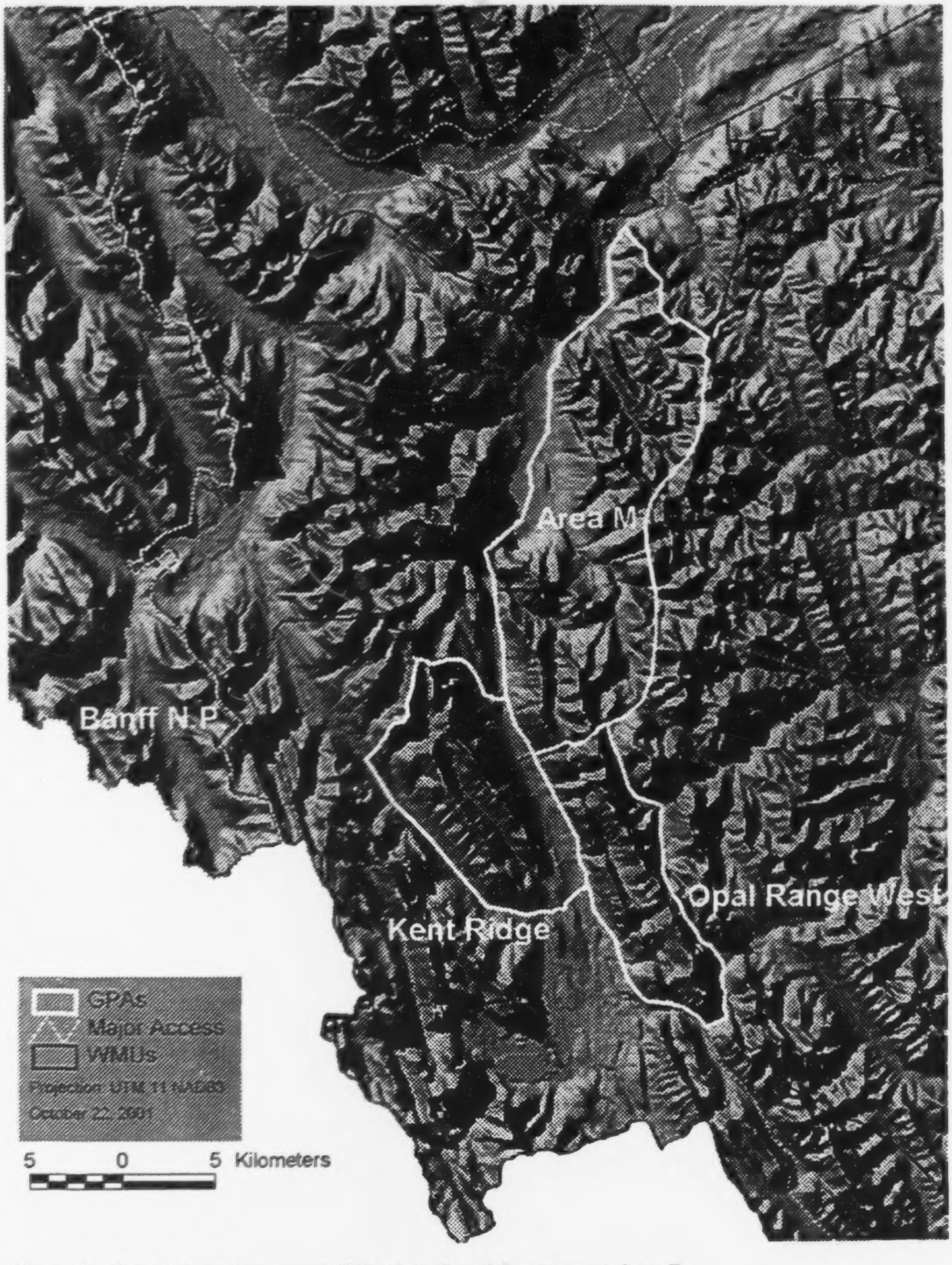

WMU 402
North End Divide
Area R
Area D
Area Q
Upper W. Castle
Area C
Area O
Area B
GPAs
Major Access
WMUs
Projection: UTM 11 NAD83
October 22, 2001
10 0 10 20 Kilometers

Figure 6. Goat Population Areas (GPAs) in Goat Management Area A.


Area M
Banff N.P.
Kent Ridge
Opal Range West
GPAs
Major Access
WMUs
Projection: UTM 11 NAD83
October 22, 2001
5
0
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Kilometers

Figure 7. Goat Population Areas (GPAs) in Goat Management Area B.

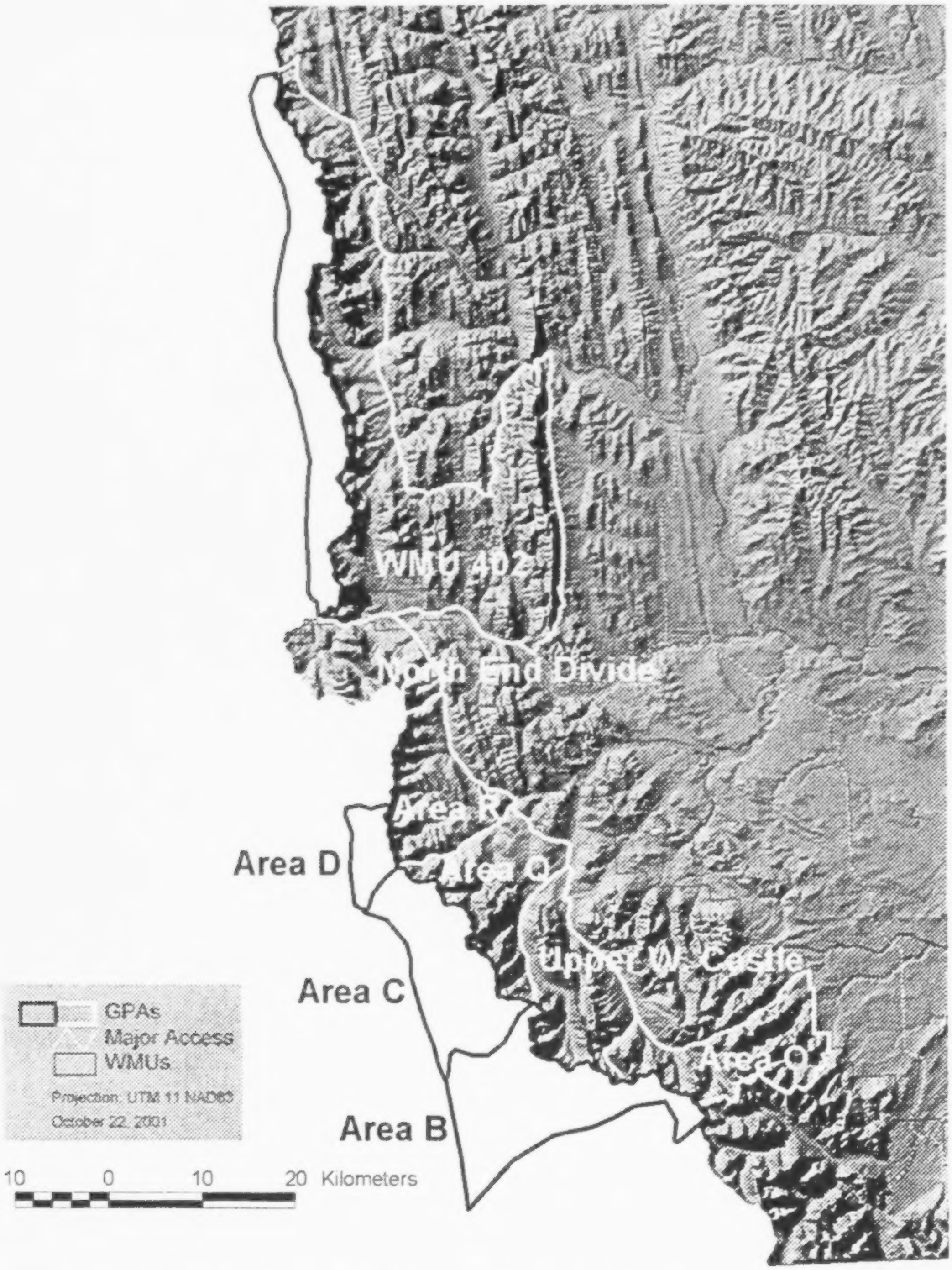

WMU 402
North End Divide
Area R
Area D
Area Q
Upper W. Castle
Area C
Area O
Area B
GPAs
Major Access
WMUs
Projection: UTM 11 NAD83
October 22, 2001
10 0 10 20 Kilometers

Figure 6. Goat Population Areas (GPAs) in Goat Management Area A.

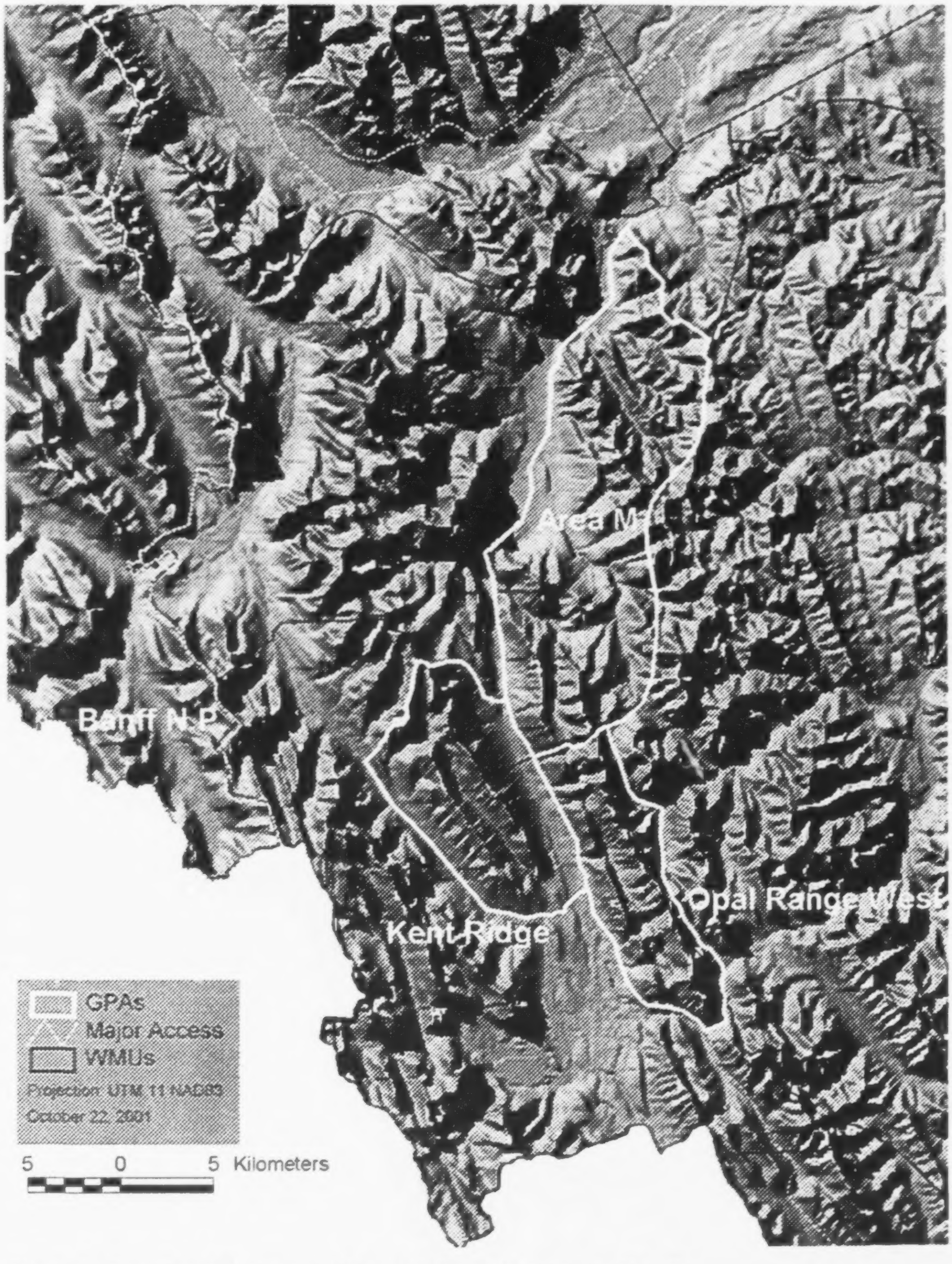

Area M
Banff N.P.
Kent Ridge
Opal Range West
GPAs
Major Access
WMUs
Projection: UTM 11 NAD83
October 22, 2001
5 0 5 Kilometers

Figure 7. Goat Population Areas (GPAs) in Goat Management Area B.

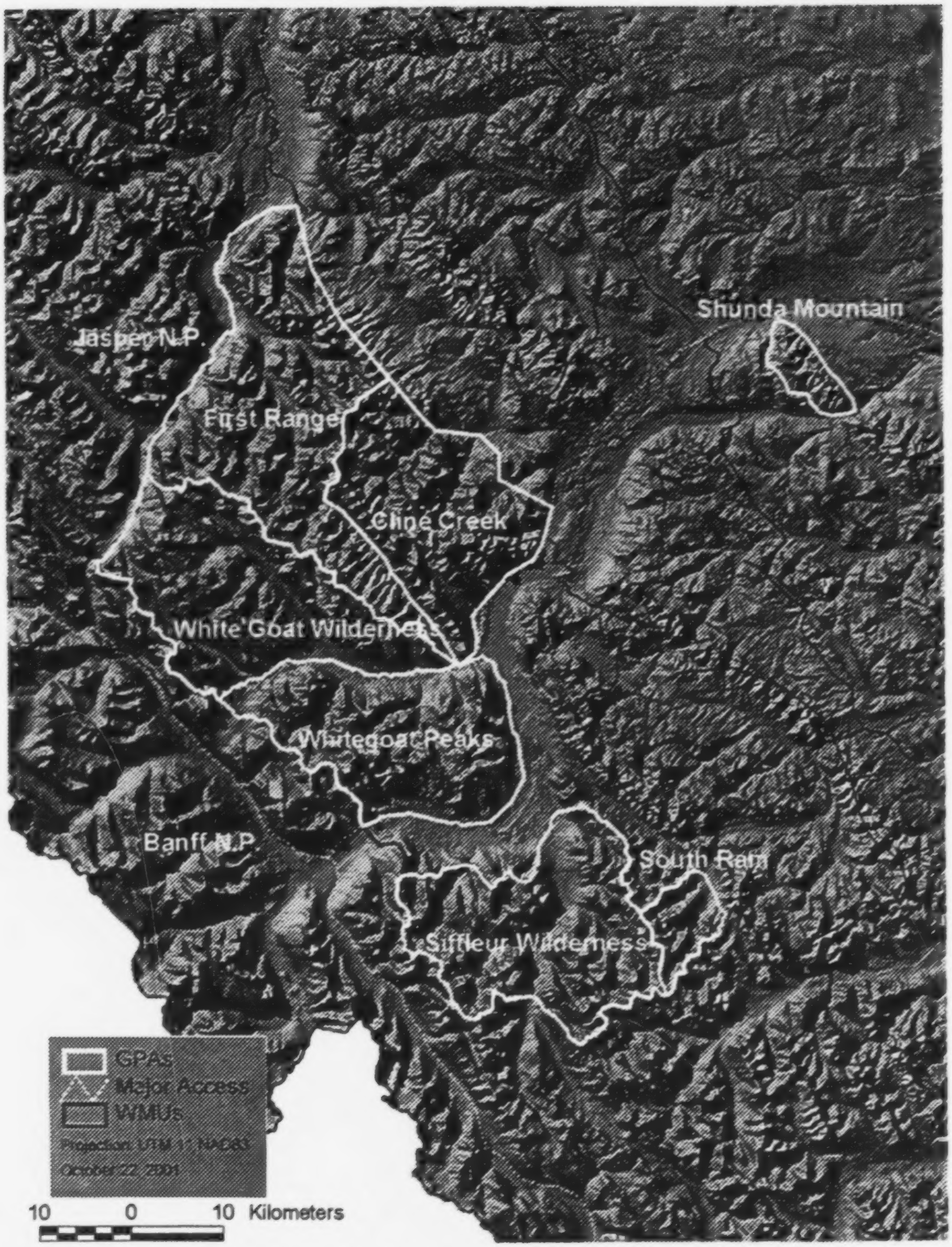
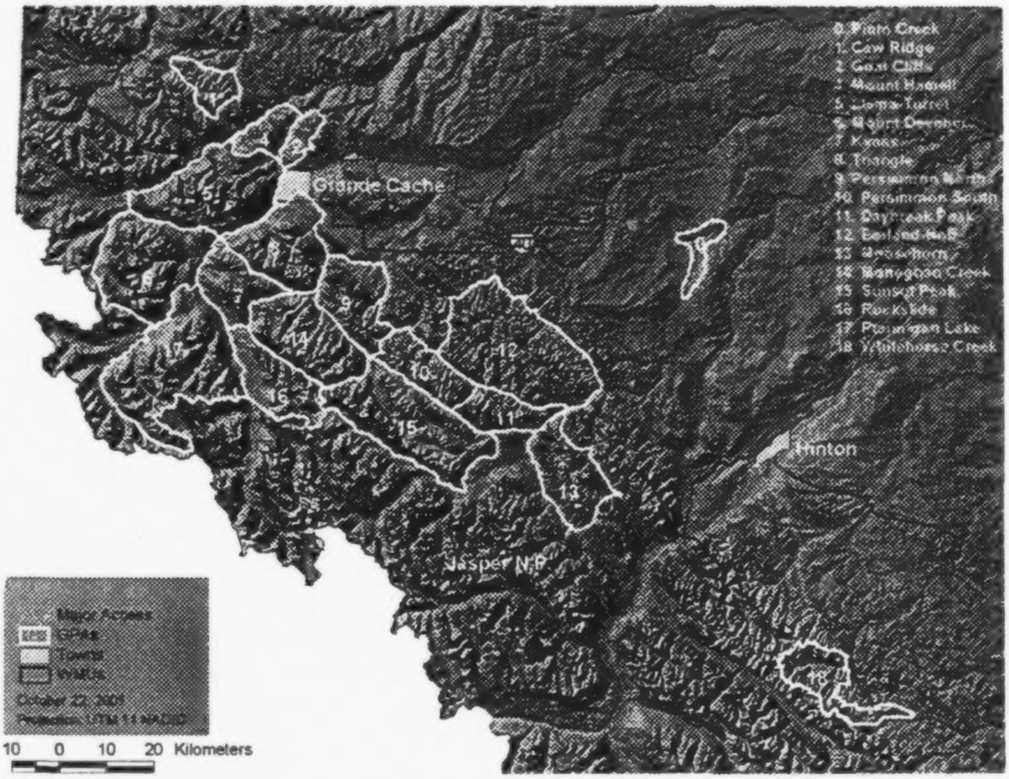

Shunda Mountain
Jasper N.P.
First Range
Cline Creek
White Goat Wilderness
Whitegoat Peaks
Banff N.P.
South Ram
Siffleur Wilderness
GPAs
Major Access
WMUs
Projection: UTM 11, NAD83
October 22, 2001
10
0
10
Kilometers

Figure 8. Goat Population Areas (GPAs) in Goat Management Area C.



0. [illegible] Creek
1. Caw Ridge
2. Goat Cliffs
3. Mount Hamell
5. [illegible] Turret
6. Mount Deveber
7. Kvass
8. Triangle
9. Persimmon North
10. Persimmon South
11. Daybreak Peak
12. [illegible]
13. [illegible]
14. [illegible] Creek
15. Sunset Peak
16. Rockslide
17. Ptarmigan Lake
18. Whitehorse Creek
Grande Cache
Hinton
Jasper N.P.
Major Access
GPAs
Towns
WMUs
October 22, 2001
Projection: UTM 11
10 0 10 20 Kilometers

Figure 9. Goat Population Areas (GPAs) in Goat Management Area D.

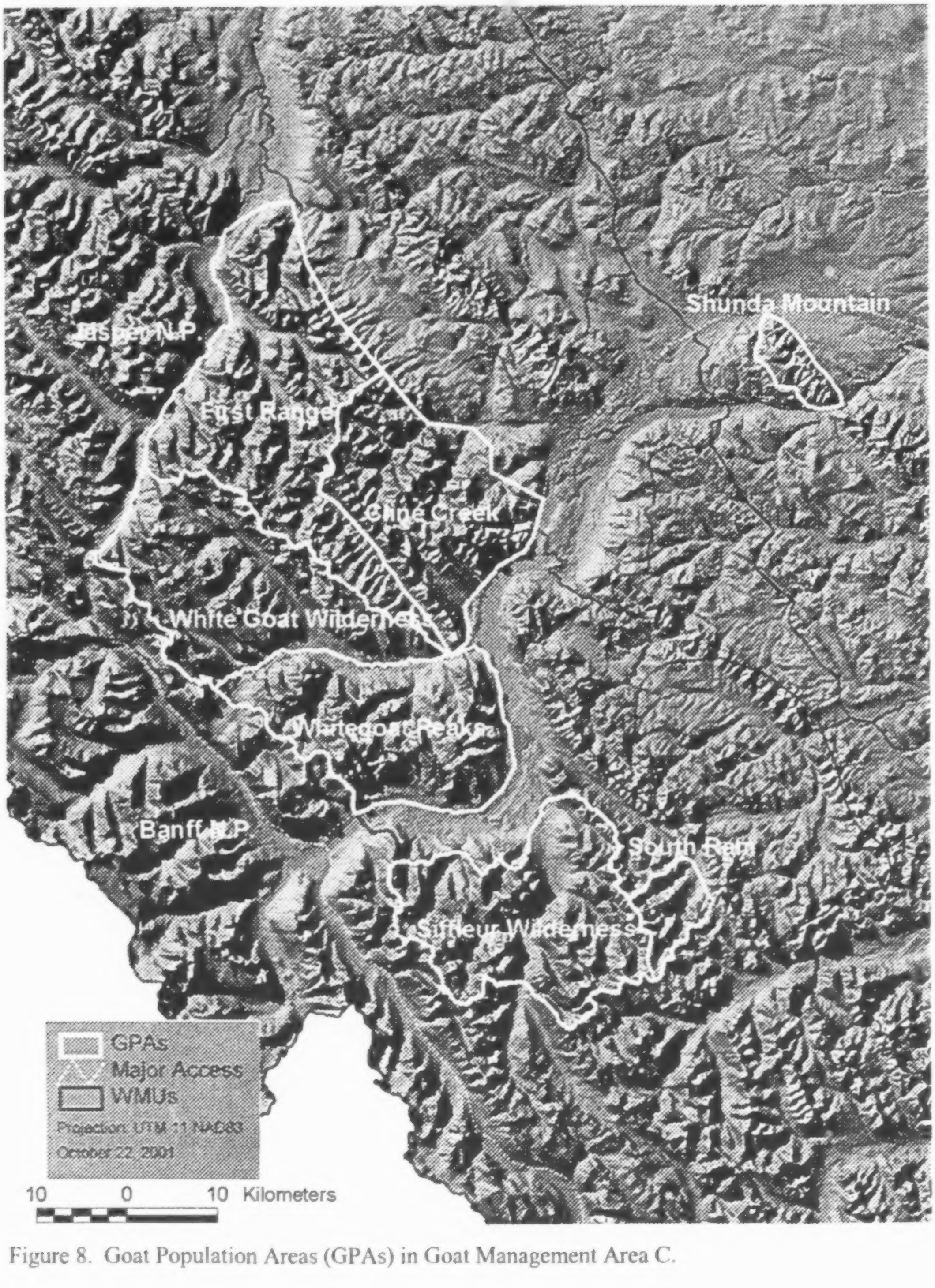
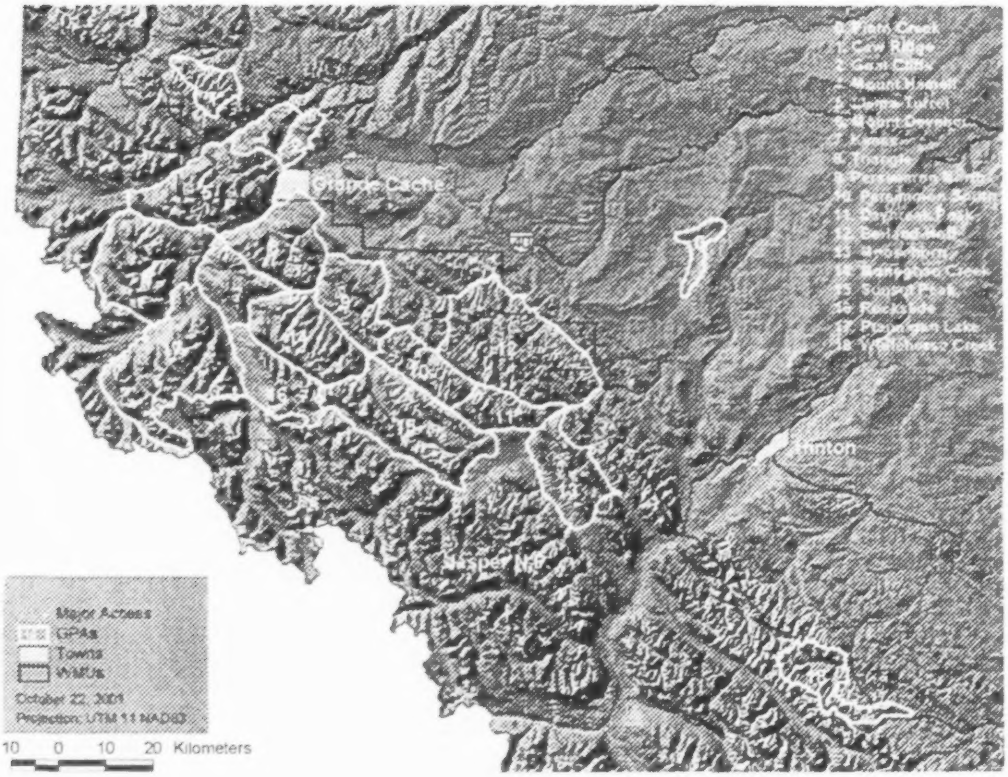

Shunda Mountain
Jasper N.P.
First Range
Cline Creek
White Goat Wilderness
Whitegoat Peaks
Banff N.P.
South Ram
Siffleur Wilderness
GPAs
Major Access
WMUs
Projection: UTM 11 NAD83
October 22, 2001
10 0 10 Kilometers

Figure 8. Goat Population Areas (GPAs) in Goat Management Area C.



1. Cow Ridge
Mount Hamell
15. Sunset Peak
16. Rock Lake
17. Ptarmigan Lake
Grande Cache
Hinton
Jasper N.P.
Major Access
GPAs
Towns
WMUs
October 22, 2001
Projection: UTM 11 NAD83
10
0
10
20
Kilometers

Figure 9. Goat Population Areas (GPAs) in Goat Management Area D.

2.3.4.2 *Survey Reports*

Goat survey data are compiled into an annual report so that provincial goals can be assessed. Each report summarizes the latest survey with respect to long-term trends, population goals and management objectives. Each report should also include an appendix of all previously collected data for the particular survey area so that old data is not lost over time. Copies of cover sheets, data sheets and annual reports are sent to a central location or the departmental library for long-term storage and protection.

Data collected for aerial ungulate surveys in Alberta usually represent samples of the total area where a population estimate is desired. In these cases, it is useful to analyze the statistical precision of these sample data. Mountain goat surveys in Alberta are counts of the total area where a population estimate is desired. Because total count data are being collected, statistical precision analysis does not apply. The data collected for mountain goats are highly variable and may not accurately reflect the population during a one-time survey. Therefore, total count data are most useful for tracking trends over time. There is a method that includes statistical precision analysis while determining changes in population status. It involves using year to year changes in age and sex ratios. Alberta does not use this method because the assumptions that various group sizes and age-sex cohorts are seen at random and the age-sex data are accurate and representative cannot be met.

2.3.4.3 *Transplants*

Goat transplants in Alberta have had limited success in the past. The procedures used have been evaluated to enhance success should goat transplants be done in the future. The three methods used to capture goats in the past are clover traps, drop nets and helicopter net-gunning. Trapping and drop nets have had very poor success in the past mainly because of unfamiliarity with the trapping area, human disturbance, poor weather, insufficient habituation of goats and unattractive bait (Ross 1992). Jorgenson and Quinlan (1996) found helicopter net-gunning to be very efficient and relatively safe for the animals, but it is expensive and dependent on good weather and finding goats on flat terrain. Also, an experienced crew is needed to correctly sex and age the individuals to be captured.

Goats should be transplanted with a sex ratio of three females to one male (Jorgenson and Quinlan 1996) to maximize the reproductive potential of the transplanted group. Nannies past their peak reproductive years should be avoided if possible, and kids or nannies with kids should also not be captured to avoid disrupting nanny-kid bonds (Jorgenson and Quinlan1996).

Goats should be transported individually in crates. Chemical immobilization of goats should be avoided. Côté, Festa-Bianchet and Fournier (1998) found that chemical immobilization reduced kid production in the following year for nannies three and four years old. Drugged females were also more likely than undrugged females to abandon their kids following capture, and the abandoned kids suffered higher mortality rates. Therefore, it is recommended that young females (two to four years old) and lactating females should not be drugged (Haviernick et al. 1998). However, Haviernick et al. (1998) recently refined the techniques for safe use of Xylazine and Idazoxan with captured animals so, in some cases, this kind of immobilization could be considered. Horn annuli counts, body lengths, shoulder heights, body weights and samples for genetic analysis should be collected from goats that do not show signs of stress. When there is no specific disease concern, testing for diseases is not necessary, but captured goats should be visually inspected for scabies, contagious ecthyma, oral papillomatosis or heavy infestations of ticks and mites (Pybus pers. comm.). Refrigerated trucks are preferred over ice/snow in the transport crates to prevent hyperthermia during ground transport.

To ensure the success of transplant programs, new herds should be protected from potentially disruptive uses until firmly established. No less than 10 to 20 goats should be released at any one time in order to establish a cohesive group. About 50 percent of the goats should be radio-collared during initial transplants to new areas to facilitate immediate program evaluation, modification and termination if unsuccessful. With subsequent transplants to the same area, released goats should be collared to maintain approximately 20 percent of the total herd with radio collars. Radio collars enable the monitoring of the goats biweekly until the home range is established and the population is sufficiently stable to census using regular aerial surveys.

2.3.5 Economic Aspects

Goats have intangible value inherent in their existence, but only the value of the products or services associated with human use can be measured. Economic value for mountain goats comes from government revenue (licence sales and taxes), recreational expenditures by hunters and non-consumptive users and commercial revenue for those providing goods and services.

Currently there is no licence revenue from goat hunting. From 1972 to 1987, an average of 45 resident licences/year were sold at prices that ranged from $10.00 to $40.00, which generated up to $1800.00 annually. Non-resident licences were not available during this period. The government receives licence fees from commercial operators such as back-country outfitters that might use goats as one of the non-consumptive viewing opportunities for their clients, and taxes from goods and services used during the non-consumptive enjoyment of goats.

Recreational and commercial hunting values are not documented specifically for goats. At $10.00/kg, the meat value of a 35 kg goat (dressed weight) is about $350.00. In addition to the licence fee, the value of a goat to a hunter might include income not earned, as well as the many hunting expenditures such as travel, lodging, food, rentals, ammunition, taxidermy and a percentage of capital equipment costs. When the season was open, these costs would have been substantial for most goat hunters because of extensive travel, overnight accommodation and specialized equipment. Boxall (1987) calculated the net annual value of maintaining the 35 goat permits available in the Willmore in 1986 to be $78,365.00 in 1986 dollars. The economic return may increase as goat populations rebuild and some areas are opened to hunting, but numbers of hunters and the accompanying economic benefits would continue to be relatively low compared to other more numerous big game species like deer.

The total economic value of primary non-consumptive wildlife-related trips by Albertans was estimated to be $431.1 million (Filion et al. 1994). Viewing large mammals represented a significant proportion of the wildlife-related trips (Boxall pers. comm.), but mountain goats probably accounted for only a small proportion of the total value, simply because of their limited distribution and relative inaccessibility. The commercial value of non-consumptive wildlife-related trips in Alberta is not documented.

2.4 SUMMARY AND MANAGEMENT ISSUES

Goat numbers in Alberta have always been relatively low and the animals restricted to steep and rugged mountain areas. There have been goat hunting seasons since the early 1900s, but there was little interest until the late 1940s. Hunting pressure and harvest peaked in the early 1960s and most populations south of the Athabasca River were seriously depleted by the late 1960s. Repopulating these depleted areas has been slow, with some previously occupied ranges still vacant. All hunting seasons were closed in 1970 and 1971 and then reopened on a limited licence basis in specific areas with large stable herds. Seasons were again closed in 1988 as even these populations appeared to be declining.

The following management issues must be addressed if viable, productive mountain goat populations are to be maintained throughout their range in Alberta and managed to meet future public non-consumptive and consumptive use expectations:

- The primary objectives for mountain goat management in Alberta include restoring depleted populations, maintaining stable populations and repopulating previously occupied goat ranges. Methods need to be identified to increase the size and distribution of goat populations in Alberta to ensure the long-term welfare of the species and to maximize the benefits from the resource for Albertans.
- Alberta mountain goat populations have been very sensitive to hunting pressure in the past, but the demand for recreational hunting of mountain goats remains high. A protocol needs to be developed to evaluate when mountain goat seasons can be opened and how the seasons will be managed if they are opened.
- The long-term welfare of mountain goats is dependent on protection and maintenance of critical goat habitat. Mechanisms should be identified to minimize conflicts with human developments and recreational activities as the growing human population places increasing demands on dwindling resources and space.
- Most research on mountain goats has involved studies of introduced herds in southern habitats without wolves and grizzly bears. Demographic parameters and estimates of harvestable surpluses from these studies do not apply to herds studied in Alberta. It is important to better understand the biology of the mountain goat in Alberta, especially factors controlling its reproductive performance and mortality and use of various habitat attributes, including the effects of range fragmentation and isolation. Research from Caw Ridge is providing data

representative of herds in the northern portion of the provincial goat range. However, more research is needed on representative herds from southern Alberta.

- Mountain goats have attributes that make them attractive for non-consumptive use. Mechanisms should be developed that take advantage of non-consumptive use opportunities in situations in which human activity can be managed and disturbance to the goats is minimized.

3.0 MANAGEMENT PLAN

3.1 POLICY FRAMEWORK

Wildlife resources in Alberta are administered according to policies outlined in *The Fish and Wildlife Policy for Alberta* (Alberta Energy and Natural Resources, Fish and Wildlife Division 1982). These policies, summarized in the following statements, provide general direction for establishing goals and objectives for mountain goat management in the province.

3.1.1 Resource Protection

"1) . . . The primary consideration of the Government is to ensure that wildlife populations are protected from severe decline and that viable populations are maintained . . ."

3.1.2 Resource Allocation

"2)(a) The wildlife resource, as a Crown resource, will be utilized in a manner which contributes the most benefit to the citizens of Alberta."

"2)(e) Wildlife will be allocated through a defined process whereby specific resources are deployed to specified uses in order to achieve stated public benefits."

"17) Wildlife must be allocated among different primary users in response to government policy. Until such time as supply and demand can be better rationalized, the following interim allocation guidelines will prevail in order of priority:

> (b) Resident recreational use of game will have precedence over non-resident use. Wildlife stocks not fully allocated or utilized to higher priority uses may be allocated commercially to non-residents."

"18) The allocation of wildlife stocks to the different primary uses does not imply that other uses cannot occur within areas where such uses are entitled."

3.1.3 Recreational and Educational Use

"8) A variety of wildlife recreational opportunities, in addition to hunting, will be available for the benefit and enjoyment of Albertans."

"9) The Government will promote the use of wildlife for the educational benefit of Albertans."

"21) A variety of hunting opportunities will be available for the recreational benefit and enjoyment of Albertans . . ."

3.1.4 Commercial Use

"22) The Division will encourage an environment that promotes the growth of the tourist industry . . ."

"22)(b)(ii) The Division will pursue this policy through:

(e) Managing wildlife to produce marketable use opportunities."

3.2 MANAGEMENT GOALS AND OBJECTIVES

3.2.1 Managing Mountain Goat Populations and Habitat

Goal

To maintain viable, productive and interconnected populations of mountain goats throughout their range in Alberta.

Objectives

- Meet established summer population targets for surveyed Goat Population Areas by 2010.
- Establish summer population targets for all Goat Population Areas not currently surveyed, including occupied range and vacant historic range, by 2005.
- Re-establish populations of goats as per targets on vacant historical ranges in Alberta by 2010.
- Monitor the distribution, size and age-sex structure of mountain goat populations in each Goat Management Area using established survey protocols and frequencies.
- Develop cooperative population management strategies with British Columbia and Jasper, Banff and Waterton Lakes National Parks for management of inter-jurisdictional herds.

Goal

To maintain viable, productive and interconnected habitats for mountain goats throughout their range in Alberta.

Objectives

- Identify and map the habitat, including connective habitats, in all current and historically occupied Goat Population Areas by 2002.
- Evaluate the distribution, suitability and effectiveness of goat habitat in each Goat Population Area by 2005, including critical habitat elements such as escape terrain, winter range and connectivity to adjacent habitat.
- Establish habitat targets (e.g., location, size and connectivity to adjacent habitats) for each Goat Population Area in concert with the establishment of population targets by 2005.
- Develop habitat management strategies that protect sufficient habitat to support the summer and winter goat populations for each Goat Population Area, based on the assessments of habitat suitability and effectiveness, and established habitat and population targets, by 2006. Included are the development and implementation of interim habitat protection guidelines that

are necessary to minimize future impacts of human use, including industry, recreation (individual and commercial), infrastructure and any other human activity, by 2001. Particular attention needs to be focused on core cliff complexes, winter ranges and habitat that maintains connectivity between adjacent complexes.

- Develop cooperative habitat management strategies with British Columbia and Jasper, Banff and Waterton Lakes National Parks for management of the habitat of inter-jurisdictional herds.

3.2.2 Managing Human Use of the Mountain Goat Resource

Goal

To provide a variety of opportunities for Albertans to benefit from the non-consumptive and consumptive use of the mountain goat resource.

Objectives

- Identify suitable locations and develop site management plans for non-consumptive use opportunities, such as viewing and photography, by 2005.
- Provide opportunities in each of the Goat Management Areas for limited resident recreational hunting of mountain goats where populations meet the established criteria for opening a hunting season.
- Acknowledge the rights of Treaty Indians (in accordance with paragraph 12 of the Natural Resources Transfer Agreement) to harvest goats as part of their subsistence needs in a manner that does not jeopardize the primary goal of resource protection.

Goal

To provide opportunities for the study of mountain goats to increase our knowledge and enhance the conservation and management of the species in Alberta.

Objectives

- Encourage scientific studies of mountain goat population dynamics, habitat use and responses to human disturbance in each of the Goat Management Areas.
- Partner with post-secondary institutions to foster graduate research on mountain goats and provide the necessary logistical and professional support needed for these research projects.

Goal

To provide information to Albertans and others to enhance their knowledge of mountain goat biology, conservation and management.

Objectives

- Provide information that highlights the biology, conservation, management and identification of mountain goats.
- Provide information that indicates potential viewing opportunities in Alberta.
- Encourage groups such as the Conservation Education WISE Foundation to incorporate mountain goat management information in their conservation education programs.

Goal

To provide opportunities for Albertans to benefit economically from the mountain goat resource.

Objectives

- Establish criteria for permitting non-consumptive, tourism-based outfitting to view mountain goats.
- Provide the opportunity for the outfitting industry to guide resident hunters.
- Provide mountain goats for zoological display to enhance public enjoyment and for education, subject to the availability of surplus animals in specified goat populations.

3.3 MANAGEMENT STRATEGIES

3.3.1 Managing Mountain Goat Populations

There will be three geographic frames of reference for discussing goat populations and habitat. They are the Goat Management Area (GMA), Goat Population Area (GPA) and Goat Hunting Area (GHA). The provincial goat range is subdivided into four broad groupings or GMAs as shown in Figure 5. GPAs are Wildlife Management Units (WMUs) or portions of WMUs that encompass one or more goat herds and individuals that regularly interact with one another (see Figures 6-9). The GPA is used as the basis for conducting population inventory surveys and establishing population and habitat goals. GHAs are geographic areas that are used to allocate goat hunting opportunities (see Figures 3 and 4). GHAs will often be the same as the GPAs, but in many cases will be smaller than the GPAs to direct the harvest to specific herds within a GPA.

The important elements of managing goat populations in Alberta are laid out in the five objectives under the population goal (see Section 3.2.1). The objectives are establishing and meeting population goals; repopulating vacant historic ranges; monitoring the distribution, size and age structure of goat populations; and developing cooperative management strategies for management of inter-jurisdictional herds.

3.3.1.1 *Establishing and Meeting Population Goals*

A population goal is defined as the number of goats that can be sustained in a Goat Population Area in long-term balance with the range and human use. Goals provide a focus for future population, habitat and human use management programs. The initial process for establishing goals is to evaluate historical numbers.

Systematic population surveys were not widespread until the late 1960s, but there were population estimates prior to this time. Webb (1959) estimated a provincial population of 3000-4000 goats. Quaedvlieg at al. (1973) based their estimate on survey information and indicated the provincial population to be only 1000. More recent estimates are provided for some goat ranges in Section 2.2.3 (Transplants), and a recent estimate is provided in Table 12. A population goal of 2500 by the year 2000 was suggested in a 1991 draft of a provincial goat management plan. In the last nine years, the overall estimated number of goats in Alberta has remained relatively stable (Table 14). However, some Goat Management Areas have had large increases in the number of goats, whereas others have had declines (Table 14). Recent surveys and estimates suggest there are about 1650 goats on provincial lands (Table 12), and only 7 out of 35 GPAs have reached the population goals set in 1991.

Table 14. Recent numbers of observed mountain goats in each Goat Management Area (GMA) compared to totals from the same populations in 1991 or just prior to 1991.

GMA[a]	1991 Total	Recent Total	Percent Change
A	79	252	319
B	380	345	-9
C[b]	348	195	-44
D	779	860	10
Total	1586	1652	4

[a] GMAs: A = Prairie Region; B = Bow Region; C = Parkland Region; and D = Northern East Slopes and Northwest Boreal Regions.

[b] The large reduction in GMA C was mainly due to a significant decline in the number of goats in the White Goat Wilderness Area – from 91 goats in 1987 to 2 goats in 1998.

Because there has been only a 4 percent increase in provincial goat numbers within the last nine years, a large increase in the number of goats in the province within the next decade seems unlikely. The long-term average annual increase, for selected populations not being hunted between 1972 and 1999, was about 1.8 percent per year (Figure 10). Applying this percentage increase to the current estimate for populations on provincial lands of 1652 (Table 12), the population would not exceed 2000 within the next decade. This percentage provides some direction for establishing the upper limit for provincial goal. However, goat populations need to be managed on a Goat Population Area basis, so it is important to have goals for each GPA.

Establishing population goals for all the GPAs is difficult. There are limited reliable historical data with which to identify vacant or under-stocked ranges. Alpine ranges have not been analyzed or evaluated for their potential to support mountain goats. Even ranges with known goat populations have not had detailed range condition inventories, nor have their carrying capacities been estimated. Such information will be needed to establish more refined population goals in the future.

Population goals have been established for 33 Goat Population Areas within 19 WMUs that have sufficient historical data (Table 15). Long-term mean population estimates, based on large sample sizes for a few GPAs, and knowledge of the local wildlife managers, established that 75 percent of the highest estimate in a GPA was a reasonable goal for most GPAs. Using this method, a population goal was established for all but 7 of the 33 GPAs. Within these 7 GPAs, the local wildlife managers indicated the goals should be higher than the 75 percent because these 7 GPAs were considered to be in the recovery phase during the period of the surveys.

The current number of goats estimated in surveyed Goat Population Areas of the province is about 1300, with a long-term goal of around 1740 (Table 15). This increase will be attained by increases of 5 goats in Area A, 68 goats in Area B, 116 goats in Area C and 349 goats in Area D, for a provincial total of 538 (Table 15). There are also currently 11 areas in which the estimated population is above the goal, totaling 121 goats. Future census data and habitat inventories will allow refinement of population goals, as will habitat evaluations required for transplant programs and the habitat management strategies outlined in Section 3.3.2.

Meeting population goals will not usually involve active intervention. It will be a case of protecting and providing the necessary habitat and allowing the population to slowly increase to goal levels. Active intervention will be required in areas designated for transplants to repopulate vacant historic ranges or to supplement existing herds. However, there are some problems with transplanting (see Section 3.3.1.2) that must be resolved before resuming this program.

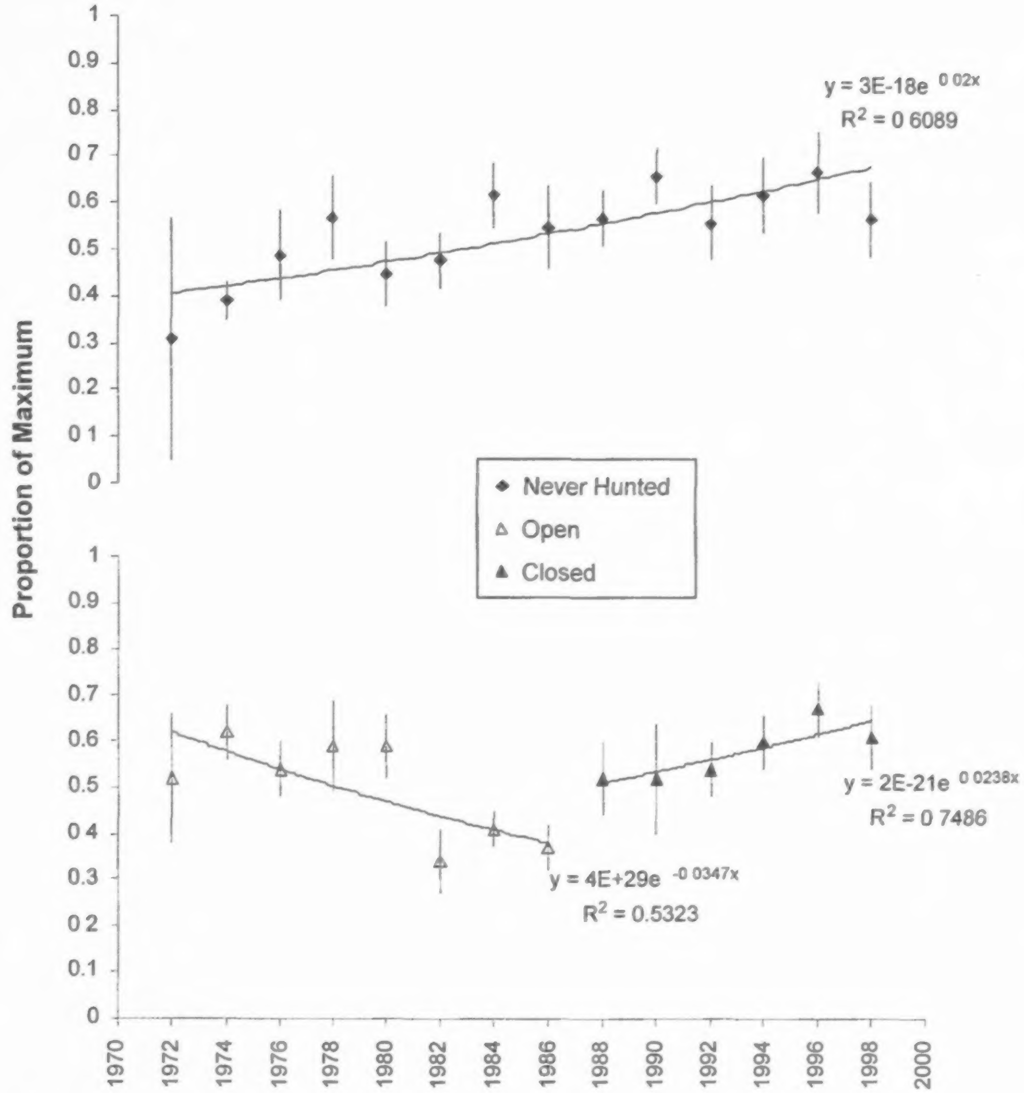


Figure 10. The three regression lines indicate the trends in an index of mountain goat populations for groupings of Goat Population Areas (GPAs) in Alberta between 1972 and 1999. The number of goats observed during each survey in each GPA was divided by the maximum number of goats ever observed within that GPA to create an index of that population's status. These decimal proportions were then averaged for all the GPAs in the group for a period of two years to create the index data point. Each data point represents the data from the current year and the year following. An index of 1 would indicate that the populations in all GPAs in the grouping reached their maximum during the particular two-year period. Error bars are ±1 Standard Error. GPAs were excluded from the index if their average population size was under 20 (Table 15). The top line is for GPAs that were never hunted during 1972 to 1999. The bottom lines represent groupings of GPAs that were hunted from 1972 to 1987 followed by no hunting from 1988 to 1999.

Table 15. Population goals for surveyed Goat Population Areas in the four GMAs in Alberta.

GMA	WMU	GPA	Mean	High	Year[a]	N[b]	Recent[c]	Goal[d]	Increase Required
A	306	Livingstone	20	20	1996	1	20	25	5
	400	Area O, B and Upper West Castle	57	74	1997	11	55	55	0
	400	Area Q and C	53	74	1999	13	74	55	0
	400	Area R, D and North End Divide	35	63	1983	12	53	50	0
	402	WMU 402	31	53	1994	4	50	50	0
Total for Goat Management Area A			196	284			252	235	5
B	408	Area M	76	125	1988	6	45	94	49
	648	Kent Ridge	43	51	1992	6	50	38	0
	648	Opal Range West	36	51	1990	4	19	38	19
Total for Goat Management Area B			155	227			114	170	68
C	328	Shunda Mountain	9	18	1987	13	12	14	2
	422	South Ram	16	18	1998	2	18	14	0
	430	Cline Creek	40	72	1996	7	26	54	28
	432	First Range	12	13	1990	2	13	10	0
	432	White Goat Peaks	54	81	1987	6	45	61	16
	736	Siffleur Wilderness	47	77	1966	11	31	58	27
	738	White Goat Wilderness	25	91	1987	11	2	68	66
Total for Goat Management Area C			203	370			147	279	139
D	344	Pinto Creek	17	28	1999	9	28	28	0
	438	Whitehorse Creek	7	22	1981	6	1	20	19
	439	Moosehorn	24	75	1979	24	10	56	46
	440	Berland-Hoff	34	58	1979	11	30	60	30
	440	Daybreak Peak	37	109	1979	20	18	82	64
	440	Persimmon North	51	93	1980	17	21	70	49
	440	Persimmon South	26	63	1996	11	62	47	0
	441	Goat Cliffs	40	86	1995	18	72	65	0
	442	Kvass	12	21	1981	15	2	20	18
	442	Monoghan	57	107	1975	18	58	80	22
	442	Mount Deveber	70	107	1998	10	107	80	0
	442	Ptarmigan Lake	40	63	1997	4	63	60	0
	442	Rockslide	33	60	1995	10	11	45	34
	442	Sunset Peak	24	40	1979	16	23	30	7
	442	Triangle	37	98	1973	18	20	74	54
	444	Llama-Turret	77	133	1992	23	101	100	0
	444	Mount Hamell	59	88	1998	19	60	66	6
	446	Caw Ridge	71	101	1999	19	101	76	0
Total for Goat Management Area D			716	1352			788	1059	349
Total for all Goat Management Areas			1270	2233			1301	1743	561

[a] Year in which high was recorded.

[b] Number of surveys from which mean and high were determined.

[c] Data from the period 1997-2000.

[d] Summer population goal.

3.3.1.2 *Transplanting*

Alberta's goat transplant program has had problems during its history (Section 2.2.3). Capture methods frequently had poor success and were very expensive. In 1992, over $75,000.00 was spent to transplant two goats (Ross 1992). Traps often caught goats that were not prime producers, and some goats died during the transplant process from capture myopathy and drug overdoses. Many of the transplanted goats dispersed out of the target area and suffered high predation losses during their travel. Finally, the nannies that remained in target areas have had poorer than expected reproductive output, and populations have grown very slowly even though it was anticipated that the release sites would have unexploited forage and cover resources. Because of past problems, a goat transplant program is not recommended for the immediate future but may be important for the repopulation of vacant range and to supplement some existing populations. Methods to overcome the reasons for poor success in the past, including new capture, transport and release techniques, should be explored.

Prior to any future goat transplants in Alberta, a detailed and thorough site selection process is needed. Gates (1972) and Ross (1992) examined several areas to determine their suitability for goat releases. Ross (1992) prioritized the candidate sites according to historical use, forage quality and quantity, escape terrain, expected carrying capacity, interspecific competition, winter conditions, access and connectivity with other populations/ranges. The recommendations of both Gates (1972) and Ross (1992) should be reviewed, and a new list of suitable release sites should be developed and prioritized to guide transplants in the future. The list should also identify and prioritize herds warranting supplementation transplants.

First priority should go to vacant historical ranges that are still capable of supporting goats. These ranges should be ranked according to their historic herd sizes and range carrying capacities. Transplants should involve a minimum of 20 animals and should continue until that number is established or the project is deemed a failure. Transplants should be a low priority if the population goal for a particular mountain complex is <50 goats because smaller herds have a greater chance of local extirpation. Second priority should go to the supplementation of existing herds that are below their range carrying capacities. Such transplants should expand gene pools, enhance viability and accelerate growth of the supplemented herds. Areas not geographically isolated from other goat populations should receive higher priority. Isolation reduces genetic interchange and greatly increases the chance of local extirpation.

Trapping and removing goats for transplants provides some opportunity to control donor herds and improve their range condition. If possible, goats for transplants should be taken from areas such as Caw Ridge, Peter Lougheed Provincial Park or wilderness areas in Alberta where herds cannot be managed by hunting. Other jurisdictions, such as British Columbia, may also have surplus goats that could be provided for a transplant program.

3.3.1.3 *Monitoring Populations*

Mountain goat distribution, population size and age-sex composition in a GPA are important for setting and/or adjusting goals, determining status in relation to goals, allocating human uses such as recreational hunting, and establishing habitat protection priorities and guidelines. A substantial ongoing survey effort is required to monitor these population attributes. Because mountain goats are particularly vulnerable to hunting, and harvest data sample sizes are too small for monitoring population status, GPAs where goats are hunted should be surveyed annually. Several populations in Alberta have had large annual fluctuations that could only be detected by annual surveys. Annual surveys can also be used to assess reproductive success and over-winter kid survival. Survey methods and reporting are outlined in Sections 2.3.4.1 and 2.3.4.2.

Several GPAs that are not hunted should be chosen as benchmark population areas that are also surveyed annually. These benchmarks are needed to assess whether variation in hunted populations is due to hunting or a combination of hunting and natural causes. An annual survey should also be conducted if a GPA experiences a large decline in numbers. Depressed populations require more frequent surveys to assess reproductive success and determine if they are recovering. Lastly, herds that are or may be significantly impacted by major new developments or activity (e.g., new mining activity) should be surveyed annually to detect changes in population size, composition or distribution.

Remaining herds that are generally stable, not being hunted and are not threatened by major environmental change can be adequately monitored by biennial or triennial surveys. A general survey schedule is outlined in Table 16. There are only minor changes from the current survey plan (Table 13). The Goat Population Areas identified in Table 16 are shown in Figures 6-9. Two additional survey areas, Dinosaur-Torrens Ridge and Sulphur Ridge, have been added and are shown in Figure 11. Table 16 outlines a regular monitoring plan for goat management, but survey frequencies should be adjusted as the status of individual herds changes. Scattered, small herds or new herds should be surveyed periodically on a reconnaissance basis and, if necessary, added to the regular survey plan. New transplants would require additional monitoring as part of that program.

In addition to numbers of goats and their distribution, surveys can provide information on productivity in goats. The ratio of kids to 100 older goats, can be determined during the summer

Table 16. Proposed frequencies for mountain goat surveys in the four Goat Management Areas (GMAs) in Alberta.

GMA[a]	Frequency	WMU	Goat Population Area
A	Annual	400	Area O, B and Upper West Castle
	Annual	400	Area Q and C
	Annual	400	Area R, D and North End Divide
	Biennial	306	Livingstone
	Biennial	402	Continental Divide
B	Biennial	408	Area M
	Biennial	648	West Opal Range
	Triennial	408/648	Kent Ridge
C	Biennial	422	South Ram
	Biennial	430	Cline Creek
	Biennial	432	White Goat Peaks
	Triennial	328	Shunda Mountain
	Triennial	432	First Range
	Triennial	736	Siffleur
	Triennial	738	White Goat Wilderness
D	Annual	439	Moosehorn
	Annual	440	Daybreak Peak
	Annual	441	Goat Cliffs-Grande Mountain
	Annual	444	Llama-Turret
	Annual	444	Mount Hamell
	Annual	446	Caw Ridge
	Biennial	438	Whitehorse Creek
	Biennial	440	South Persimmon
	Biennial	440	North Persimmon
	Biennial	440	Berland-Hoff
	Biennial	442	Mount Deveber
	Biennial	442	Rockslide
	Biennial	442	Sunset Peak
	Biennial	442	The Triangle
	Biennial	442	Kvass
	Biennial	442	Monoghan Creek
	Biennial	442	Ptarmigan Lake
	Biennial	445	Dinosaur-Torrens Ridge
	Biennial	445	Sulphur

[a] GMAs: A = Prairie Region; B = Bow Region; C = Parkland Region; and D = Northern East Slopes and Northwest Boreal Regions.

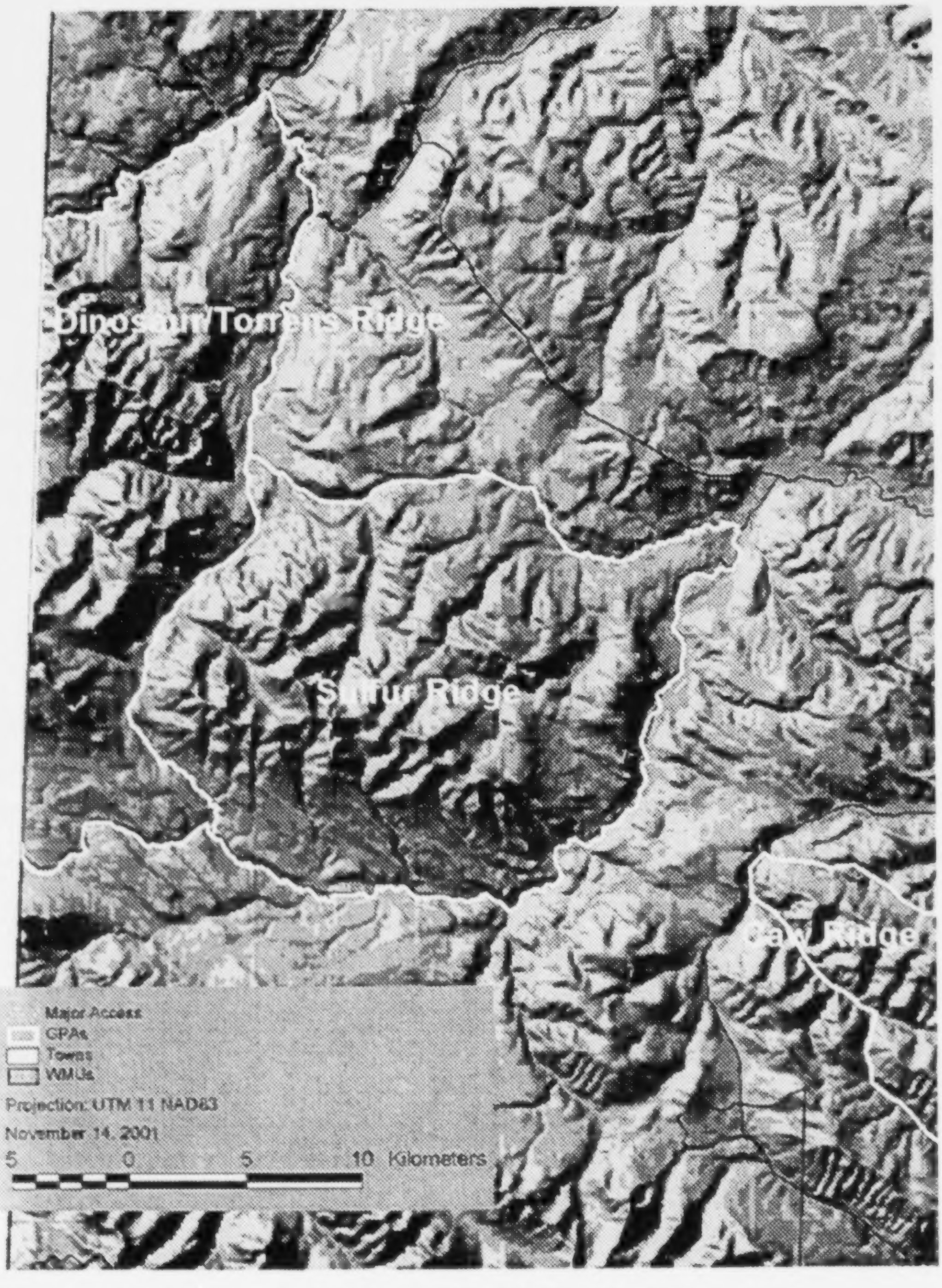

Dinosaur/Torrens Ridge
Sulfur Ridge
Caw Ridge
Major Access
GPAs
Towns
WMUs
Projection: UTM 11 NAD83
November 14, 2001
5 0 5 10 Kilometers

Figure 11. Additional Goat Population Areas (GPAs) in Goat Management Area D.

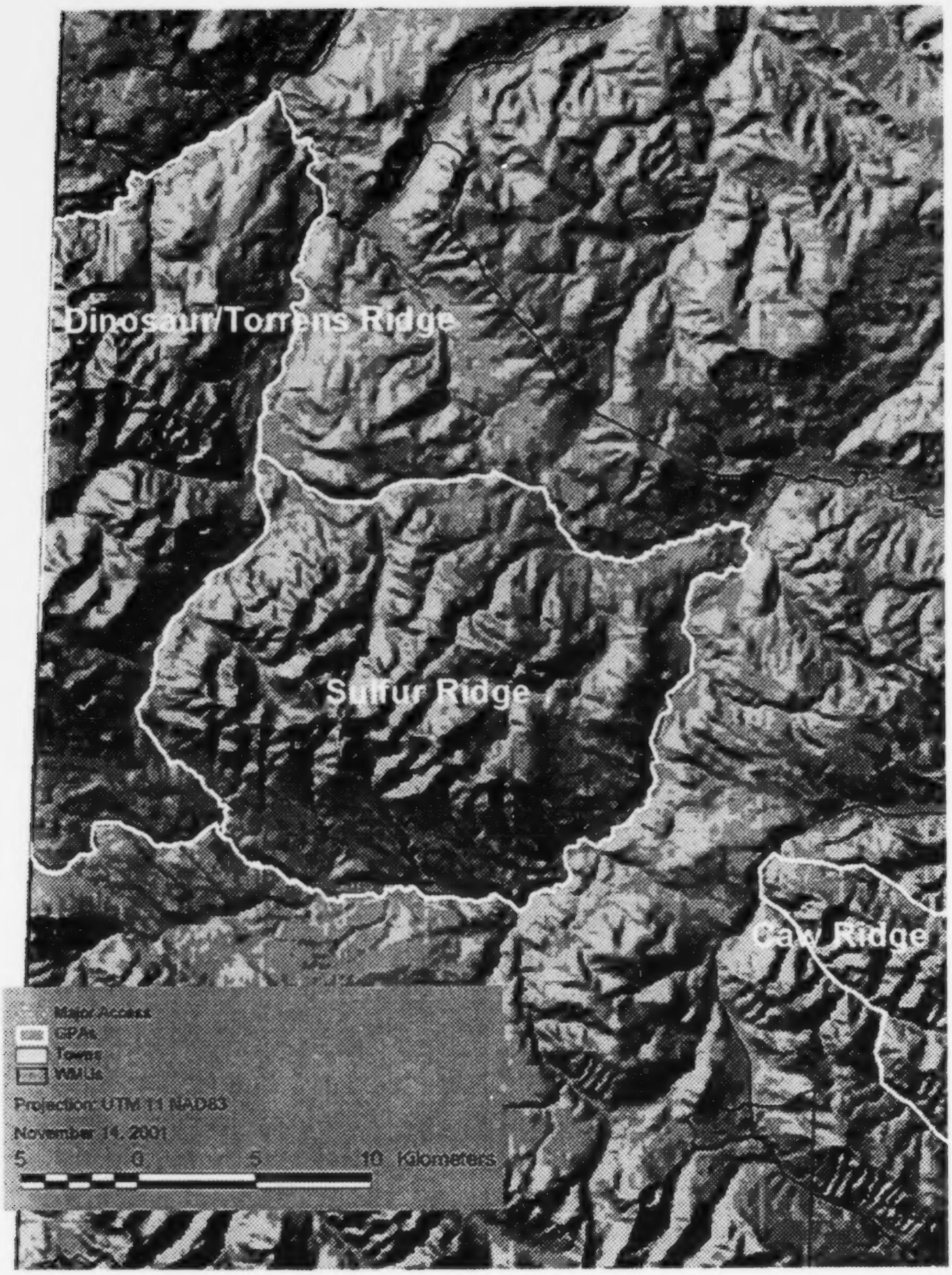

Dinosaur/Torrens Ridge
Sulfur Ridge
Caw Ridge
Major Access
GPAs
Towns
WMUs
Projection: UTM 11 NAD83
November 14, 2001
5 0 5 10 Kilometers

Figure 11. Additional Goat Population Areas (GPAs) in Goat Management Area D.

census while kids are tiny, about 2 months old. A better measure, kids per 100 adults (2 years and older), can be obtained by also classifying the yearling component. This objective is reasonable while yearlings are about 14 months old and still relatively smaller than adults, but an experienced observer is needed because the difference is subtle, especially from a helicopter.

Caution should be used when interpreting these data because yearlings are often misidentified as kids (Gonzalez-Voyer et al. 2001). Ground surveys are highly recommended to improve the accuracy of these surveys. Although the data sets for the larger herds could be analyzed with statistical precision testing of age ratio data, it is unlikely these data would meet the necessary assumptions (i.e., the various group sizes and age-sex cohorts be equally visible and the age-sex data be accurate and representative).

These indices can be used to track the direction of change in numbers in a population. Higher ratios indicate that the population has the potential to grow, whereas lower ratios indicate that the population is stable or may be decreasing. These ratios should be interpreted cautiously because goat herds, particularly smaller herds, can have high year-to-year variation in observations. It is important to follow production indices over time to establish trends.

The aerial surveys in a GPA are designed as total counts of the population, not samples. Gonzalez-Voyer et al. (2001) found that numbers from aerial surveys averaged about 70 percent of the actual goat numbers on Caw Ridge but year-to-year variation was considerable. Therefore, sightability correction factors will not be used, and actual numbers seen will be used in developing management strategies and actions.

3.3.1.4 *Determining Seasonal Distribution*

The previous section focused on summer survey information related to distribution, size and composition of the population in a GPA. Knowledge of distribution and range use during other seasons, as well as areas used primarily for movement, is also required for management of goat populations and habitat. Identification of winter ranges is especially important. Because most goat census work has been done in summer, specific winter locations for many goat herds remain unknown. It is recommended that winter ranges for these herds be surveyed by helicopter between December and March, to determine winter distribution. Herds should be systematically surveyed until locations for at least three winters have been collected for each herd. Highest priority should be given to the largest herds and those most threatened by human activities. Ground surveys to identify ranges used by males in September and October would improve hunting management. The surveys described in this paragraph are in addition to those outlined in Table 16 and would require additional resources to complete. More detailed distribution information, such as the location of kidding areas, should be collected using radio collars, but this type of data collection should be limited to research herds or herds where specific concerns have been identified.

3.3.2 Managing Mountain Goat Habitat

The important elements of managing goat habitat in Alberta are laid out in the five objectives under the habitat management goal (see Section 3.2.1). The objectives are determining the distribution, suitability and effectiveness of the habitat that can support goats; establishing habitat targets in concert with population targets; developing habitat management strategies to meet established targets, including the development and implementation of habitat protection guidelines for all human use activities in goat habitat; and developing cooperative programs with British Columbia and the national parks in Alberta to manage and protect the habitat of inter-jurisdictional herds. Goals, objectives and management strategies must be provided to the land management agencies in government and all the stakeholders that may use and have an impact on goat habitat. All parties must support the goals, objectives and strategies if habitat management and protection are to be effective. Ongoing monitoring of habitat and populations will determine if the habitat management program is successful and whether or not adjustments must be made to the management strategies.

3.3.2.1 *Identifying and Mapping Habitat*

Essentially all goat habitat in Alberta exists on public land. The primary prerequisite for habitat management is to identify and map all goat ranges, including historic or potential ranges currently unoccupied. During the first phase of this process, essential escape terrain, forage areas and winter ranges will be identified. During the second phase, kidding areas, all seasonal ranges, travel corridors and mineral licks should be identified and mapped for GPAs in which they are not known. Historic and current range use data and remote sensing technology, with appropriate levels of verification on the ground, will be used to complete this task. The target date for completion of the first phase of the identification and mapping process is the year 2002, with the second phase to be completed by 2005.

The next step is to assess the suitability and effectiveness of the goat ranges using a conventional methodology such as habitat suitability and effectiveness (HSE) models. The target date for completing this task is the year 2005.

3.3.2.2 *Establishing Habitat Goals*

The habitat goals will identify the quantity, quality and location of the various habitat elements (e.g., escape terrain, forage areas) required in each GPA to meet the needs of the number of goats identified in the GPA population goal. This task will follc completion of the inventories outlined in Section 3.3.2.1. These habitat goals should be clearly indicated in the various land use referral mapping systems so that those proposing industrial, recreational or commercial activities can avoid conflicts involving goats and their habitats. The target date for completing this task is the year 2005.

3.3.2.3 *Protecting Habitat*

To maintain viable and productive goat populations, goat habitat must be protected from the influences of competing land uses. Steps involved in the habitat protection program for mountain goats and other species are (1) establishment of habitat goals for each GPA (see previous Section 3.3.2.2); (2) integration of these goals and similar goals for other wildlife species with other uses of the land; and (3) establishment and consistent application of specific protective measures.

Integration of habitat protection goals with other land uses is accomplished through participation in regional and local planning processes, such as integrated resource plans, river basin plans and various land use development plans. Planning participation occurs through the government's land use referral process. Wildlife managers may recommend standard guidelines or conditions to protect habitat and/or special conditions unique to specific species and/or specific land use proposals. Development or land use activity plans covered within the referral process include those for timber harvesting, grazing, oil and gas exploration and development, mining, thermal and hydro power generation, dams, transportation and utility corridors, urbanization and recreation. Guidelines to maintain quality wildlife habitat generally involve restrictions on the type, intensity, location and timing of use, as well as controls on public access to a site. Important habitat may be highlighted with protective notations in the Alberta land registry if it has not been previously identified in a planning document. Some goat habitats and human activities require specific protective measures as noted below.

Core Forage Areas, Escape Terrain and Winter Range

All developments and activities, including recreational activities such as mountain climbing, should be prevented on foraging areas, cliff complexes (escape terrain) and winter ranges that are the focal points of mountain goat ranges, especially during periods when goats are normally present. This critical habitat should be retained through protective notations in the Alberta land registry.

Connective Habitat

All developments and activities should be prevented in connective habitat, especially during periods when goats are normally present, so that goats have the opportunity to move between seasonal ranges or to various habitat features like mineral licks, water or cover. This critical habitat should be retained through protective notations in the Alberta land registry.

Activity and Noise

All noise and associated activity, especially helicopter use, should be prevented within or close to goat range. Côté (1996) suggests no helicopter activity within 2000 m of goat herds. Data from his study indicate the most significant disturbance occurred when helicopters were within 500 m. Depending on the local situation, the area within 500 m should be a "no use" zone and the area from 500 m to 2000 m should be a "limited use" area, with restrictions involving the location, timing, frequency and type of use. Additional restrictions involving helicopter use might involve flight paths and altitude.

Road Development and Use

Uncontrolled and continuously expanding access, in combination with unregulated hunter harvest, is generally accepted as the primary factor that led to the decline in goat populations throughout much of their range in North America by 1970 (Foster 1977, Jamieson 1978). Most new roads and trails are developed for industrial access. The oil and gas industry annually creates significant numbers of seismic lines, pipeline trails and well-site roads, and logging and mining activities create additional access.

For protection of goats, the primary requirement is to shield core escape terrain and adjacent meadows from excessive human activity. This shielding can be achieved in large measure by restricting motorized vehicles to designated routes that avoid areas of significance or by restricting the use of routes that lead to or through seasonally critical areas. Most restrictions can be implemented through regulations applied within Forest Land Use Zones. To ensure compatibility with goats, road development should be minimal, and routed away and screened from areas significant to goats. If it is essential for industrial access to penetrate goat range, the following guidelines are recommended:

- Construction should occur when goats are seasonally elsewhere or less sensitive to disturbance. Winter construction, when goats are in their weakest condition, should be avoided.
- Entrances should be blocked with gates and incorporate line-of-sight barriers ("dog-legs") to discourage public vehicle use.
- Travel should be restricted to necessary personnel, occur at regular and predictable intervals, and involve multi-person vehicles rather than numerous individual vehicles. The same vehicles should be used for repeated trips so that goats become familiar with them.

- All access routes should be physically blocked and reclaimed when no longer needed.

Timber Harvest

Timber harvest does not usually occur in rugged, alpine goat habitats. However, goats sometimes winter on low-elevation cliffs in forested areas, and disturbances from logging and activity on logging trails have caused goats to vacate some ranges in the past (Chadwick 1973, Wright 1977). The Pinto Creek herd is an example of a herd in which the potential for future conflicts between timber harvesting and goat management exists (Harrison 1999). Harrison (1999) suggested that logging the flat areas that surround canyons and other escape terrain at Pinto Creek may force predators to use the undisturbed canyons and slopes as travel corridors, thereby concentrating predators in goat habitat. Additional information is needed on the response of predators, particularly the influence on movement and hunting patterns, to logging and associated activities such as road building and road use. Logging plans for areas significant to goats must be carefully designed to ensure cut blocks and roads are adequately set back to avoid excessive disturbance. Activity should not take place during periods when goats are present. Access roads should be blocked and reclaimed when logging is finished (see Road Development and Use on the previous page).

Recreational Developments and Activities

Recreational developments and activities can be detrimental to goat habitat or its use. For goats to fully utilize their habitat, nearby recreational undertakings must be appropriately screened or set back to respect the animals' need for security. Hotels, campgrounds and back-country campsites are of concern. Recreational trails and back country activities, such as hiking, skiing and horseback riding, should be adequately separated from goat herds. Helicopter sightseeing, hang-gliding, mountain-biking and mountain climbing must be prohibited in critical habitat because they can occur in escape terrain and eliminate the goats' options to flee. Côté (1996) found that helicopter disturbance can fragment social groups and even cause injuries (see "Activity and Noise" section on previous page). He suggested that unnecessary helicopter use be restricted within 2000 m of known goat habitat. Non-consumptive viewing, whether at stand alone sites or associated with approved developments, must be managed with the welfare of goats as the primary consideration.

Specific guidelines and programs, incorporating those above, should be developed with the Land and Forest Division and industry to ensure operations in significant goat habitats maintain the quality and effectiveness of goat habitats. Guidelines and programs should also be developed to address recreational (personal and commercial) use within goat habitats.

3.3.2.4 *Enhancing Habitat*

Goat habitats, particularly those in which herd productivity is poor, should be examined for enhancement possibilities. A list of potential projects should be developed and prioritized on a cost-effectiveness basis. There are no obvious enhancement opportunities related to goat habitats in Alberta, but consideration should be given to the following possibilities:

- Improvement in the availability of forage adjacent to cliff complexes. This improvement might be accomplished by (1) clearing timber from the edges of meadows or certain trails to make predators more visible to goats and encourage goat use of forage farther from escape terrain, and (2) removal of trees to increase wind scouring and reduce accumulation of snow on winter forage resources.
- Examination of industrial operations in goat habitat to identify potential enhancement projects. Old mine sites, for example, may provide opportunities for development of mineral licks, escape terrain or forage for use by goats.

3.3.3 Managing Non-consumptive Use

Although often in remote areas, mountain goats are available for viewing at all seasons of the year throughout their range in Alberta. Opportunities for non-consumptive use of goats would be enhanced by the following:

- Attaining the population and habitat management goals outlined in this plan.
- Identifying and developing site management plans for a few suitable sites where there can be public observation of goats. Caw Ridge, White Goat and Siffleur Wilderness Areas, Yamnuska Mountain, Peter Lougheed Provincial Park and the Icefields Parkway south of Jasper are all listed as potential mountain goat viewing areas in the *Alberta Wildlife Viewing Guide* (Alberta Forestry, Lands and Wildlife 1990). Viewing sites should be developed to control vehicular traffic and to keep goats and people safely separated (i.e., the goats should be easily viewed without disturbing them).
- Developing and providing appropriate on-site interpretive and educational materials about the life history, behavior, requirements and management of goats. Educational materials should emphasize the hazards of feeding the animals and the potential consequences of harassing them.

- Developing and providing written materials, videos, films and a web site about goats, especially for use in schools and other off-site locations.
- Permitting zoos to possess goats for zoological display to enhance the enjoyment and education of the public.

3.3.4 Managing Consumptive Use

For the foreseeable future hunting harvests must be very conservative in Alberta because:

- All data from Alberta goat populations indicate low recruitment levels compared to other goat populations further south;
- Recruitment and mortality rates vary greatly among years;
- Annual surveys of all GPAs would be manpower intensive and expensive;
- Surveys provide only limited demographic data;
- Even with education and training, hunters often harvest prime-age females; and
- Application of harvest rates previously judged to be conservative during 1975-1987 resulted in declining herds.

Consumptive use in a GPA will not be considered until the population goal has been met. Additionally, GPAs designated as research areas or designated as donor transplant herds should not be considered as consumptive use areas until they are no longer needed for these purposes.

3.3.4.1 *Recreational Hunting*

Hunting strategies and quotas will be applied to Goat Hunting Areas (GHAs), which in some cases will be the same geographic unit as a GPA, but in other cases will be smaller than GPAs, to ensure an even distribution of harvest and to avoid excessive harvest of easily accessible herds within a GPA.

Opening and Closing Seasons

The evidence for Alberta suggests that hunting is additive rather than compensatory in relation to natural goat mortality (K.G. Smith 1988; for other areas see Hebert and Turnbull 1977, Kuck 1977 and C.A. Smith 1986). The effects of one severe winter can disrupt the delicate balance between population surplus and harvest levels (K.G. Smith 1988). Therefore, it is necessary to have strategies that allow for the opening and closing of hunting seasons in the GHAs. The following criteria must be met prior to opening a special licence hunting season in a GPA:

- *The GPA must have 10 years of population survey data collected while the hunting season was closed.* Significant natural fluctuations in population size and composition over time demonstrate the need for long-term benchmark data prior to establishing goals and initiating a hunting season. These data will ensure the GPA has a valid population goal and the population is stable or growing prior to the initiation of the harvest. Furthermore, these data will indicate the range of natural variation that should be expected once the season is initiated.
- *The population goal for the GPA must be equal to or greater than 50 animals.* A population of less than 50 animals should not be considered for harvest due to wide fluctuations in numbers and sensitivity to female harvest. GPAs with a population goal below 50 animals may occasionally have numbers above 50 but should not be hunted unless there is a resource management concern (e.g., evidence of damage to their range).
- *The GPA must have been surveyed during the year prior to and in the same year as the proposed season.* The previous year's survey data will be used to decide whether to have a season or not and to establish a preliminary harvest goal. The current year's data will be used to adjust the harvest goal, if necessary, and may lead to a season closure if the population estimate falls well below the goal (see criteria for season closure in the following text).
- *The number of goats observed during the summer survey must be at or above the population goal for the GPA (Table 15).* If a GPA does not meet this criterion, hunting in adjacent GPAs that have met the season opening criteria will not be affected.

After a special licence hunting season in a GPA has been opened, it will close when:

- *The summer survey reveals numbers between 0 and 20 percent below the goal for two consecutive years, or greater than 20 percent below the goal in any one year.* In Goat Management Area D, the average fluctuation in numbers of goats counted during annual surveys of large (>50 goats) herds is 20 percent. This information suggests that a year to year fluctuation of 20 percent in survey results is normal and should not be interpreted as a population trend. The variation is more likely due to year to year changes in visibility of goats during the survey than actual changes in the population size; however, two consecutive years of numbers below the goal will be treated as a downward trend.
- *The summer sex ratio of adult males to adult females falls below one male for every three females in a GPA.* Because the literature does not provide information on the minimum sex ratio needed to maintain kid production, this conservative goal will be used until research indicates a different goal is appropriate. The goal for this criterion uses the adult male to female sex ratios on Caw Ridge as a guideline (mean 0.41, range 0.27-0.55; Festa-Bianchet et

al. 1994, Côté pers. comm.). Local wildlife managers should determine the necessary frequency for collection of adult sex ratios. However, these data should be collected when the harvest of adult female goats exceeds 33 percent of the total harvest in a GPA.

Harvest Rate

Sorensen (1999) developed a model of goat population dynamics using Caw Ridge data (population structure from Table 2, reproductive success from Table 3, survival from Table 5). The model was designed to identify the *maximum* harvest that a goat population could sustain under average conditions. The model assumes that the long-term averages of composition, sex ratios and reproductive success from Caw Ridge are sustainable. Successful parameters were defined as those that allow the population to sustain its numbers for 50 years with an adult sex ratio equal to or greater than one adult male to three adult females in the summer.

The model suggested a sustainable harvest rate of 3 percent of the summer population. The model indicated that a population of 100 goats, of which 45 are adult females, could only sustain an annual harvest of 2 adult males and 1 adult female. If more than one adult female was harvested in this population, the hunting area would have to be closed until recruitment replaced the harvested females. If more than 2 males were harvested in this population, the male to female sex ratio would be lower than 1:3 and the season may have to be closed, depending on adult male recruitment. The model should be used cautiously because it uses long-term averages, does not incorporate all of the influences on goat populations and is based on only one herd.

The model results are similar to harvest rate suggestions in a 1988 publication (K.G. Smith 1988) and the 1999 progress report from the Caw Ridge studies (K.G. Smith et al. 1999). K.G. Smith (1988) suggested that annual harvest rates should be below 3 percent in order to be sustainable. K.G. Smith et al. (1999) indicated that recruitment at Caw Ridge, in a population of 127 goats, was 1-3 adult males (3-year-olds) each year. Therefore, there is some risk if the harvest rate is set at 3 percent in a given year even though the total number of surplus males may also be 3 percent in that year (K.G. Smith et al. 1999). Higher harvest rates, based on studies of introduced, more southerly populations (Bailey 1986, Williams 1999) do not appear to be sustainable in Alberta.

Figure 10 displays two different data sets from the period 1972 to 1999. The data from a group of GPAs that were not hunted from 1972 to 1999 indicated a growth rate of 1.8 percent annually. Data from the second group of GPAs indicated that the population declined at a rate of 3 percent annually between 1972 and 1987 while it was being harvested at a rate of 5 percent annually. After the hunting season was closed for this second group of GPAs, the population increased at an annual rate of 2.2 percent between 1988 and 1999. These data suggest that the maximum harvest rate should be in the range of 2 percent of the summer population estimate in a GPA.

Considering the model results, the data from K.G. Smith (1988) and K.G. Smith et al. (1999), and the analysis represented by Figure 10, the maximum harvest rate for a GPA should be 3 percent of the observed number of goats in the summer survey. The actual harvest rate used in any one year may be less than 3 percent, depending on the population size and composition, the previous age/sex composition of harvest and adult sex ratios if known. The harvest goal should not exceed 3 percent of the total number of goats observed in the summer survey, even if the observed number of goats is above the population goal. If more than one-third of the harvest within a GPA is females, the season may be closed for one or more years unless there is data that indicates this closure is not necessary (e.g., strong recruitment levels from the yearling class). Because many GPA populations are well below 100 goats and harvest goals may be only one goat, techniques such as designating alternate GHAs within a GPA or alternate year hunting would have to be considered to maintain the desired number of adult females and males.

Licensing

Goat hunting licences, each valid in a specific GHA, should be available only through a special licence draw. Special licences would be valid for goats of either sex with horns longer than ear length, but hunters will be encouraged to take males. The number of special licences allocated for hunting would be the same as the harvest goal for the first three years of seasons for a GHA, assuming a hunter success rate of 100 percent. After the third year of hunting in a GHA, special licence numbers could be increased on the basis of average hunter success rates in the most recent three years.

Special archery-only seasons are unnecessary for quality bow hunting because there would be so few goat hunters in any GHA. In Washington State, the success rate for goat hunters using archery equipment was about half the success rate of those using "any legal weapon" (Johnson 1986). Therefore, the number of hunters choosing to hunt goats with a bow would have to be monitored carefully because their lower success could influence success rates within a GHA.

Season Dates

Hunting seasons for goats should not open until mid-September so that the goats have quality capes, and to avoid hunter crowding during the first weeks of the bighorn sheep season. Seasons should be long to provide hunters with greater opportunity and choice. Long seasons should also reduce the tendency to take the first goat seen and provide time to look for better trophies and confirm the sex of potential targets. Because winter can come early in alpine habitat, goat seasons should close by the end of October, before accumulating snow restricts movements of both goats and hunters. This timing also coincides with the closure of the bighorn sheep season.

Selection of Male Goats and Hunter Training

Goat hunting harvest should be focused on adult males to maintain maximum productivity and recruitment (i.e., minimize hunting mortality of adult females, kids and yearlings). Outside the rut, males are usually found in smaller groups, often alone or in pairs in the case of larger, mature billies (Risenhoover and Bailey 1982). Wright (1977) observed that 81 percent of all adult male goats were in groups of four or less; 72 percent of adult females were in groups of more than four and 94 percent of them in groups of more than three. Therefore, it should be illegal for hunters to take a goat from a group of goats with four or more goats, to take any goat accompanied by a kid, or to take a goat from any group that has one or more kids in it. Harvest rates should be kept low to provide an added safeguard.

Because it is difficult to separate males and females in the field, there should be a compulsory education requirement for goat hunters. Educational materials and programs should cover sexing of goats in the field and the importance of maintaining the female portion of the herd. Slides, an educational pamphlet and a web site are possibilities to further educate hunters and non-hunters to improve their goat sex identification skills and to describe the current goat management approach.

Registration and inspection, to determine and verify the sex and age of harvested goats, are essential components of monitoring and adjusting the harvest and should be compulsory.

3.3.4.2 *Subsistence Hunting*

There is little documentation related to subsistence harvest of goats by Treaty Indians. However, anecdotal evidence from field staff indicates this harvest has been quite low in recent decades. Until there is evidence that this harvest is affecting sustainability of populations in individual GPAs, no specific management actions are planned.

3.3.5 Managing Scientific and Educational Use

3.3.5.1 *Scientific Use*

There is a need to expand the knowledge base on goat population dynamics, habitat use and responses to human disturbance in Alberta. Although the research work at Caw Ridge has provided valuable information in this regard, it is important to encourage similar work on goats in the three other Goat Management Areas in Alberta. Some research topics for consideration are:

- How do factors such as weather, habitat quality, predation and human disturbance influence mountain goat productivity and survival?
- What are the important elements of goat habitat, and how do goats use this habitat on a daily, seasonal and yearly basis?
- Harvesting females in some southern goat populations has increased productivity. Can this type of harvest work in Alberta, and how important are individual female goats to the overall productivity of the herd (i.e., how does age, position in the dominance hierarchy or genetic lineage affect productivity)?
- What is the effect of adult sex ratios below one male per three females?
- What influence does discontinuous distribution and herd isolation have on genetic diversity, survival and sustainability of populations?

It will be important to maintain ongoing dialogue and partnerships with post-secondary institutions so they can carry out the necessary research. It is also important that Fish and Wildlife Division staff provide professional advice (e.g., through membership on graduate research committees) and logistic support for research projects.

3.3.5.2 *Educational Use*

Information can be provided through various print and electronic media such as pamphlets, videos and the internet. Mountain goats are displayed on a pamphlet that was produced within the department; the pamphlet included information about all the cloven-hoofed animals in Alberta. Consideration should be given to updating the information regarding goats and the other cloven-hoofed animals and reprinting the pamphlet. The production of a video on mountain goat management would require a partnership or joint venture with the private sector. Another vehicle for providing educational information on mountain goats would be a web page on the departmental internet site. The web page could feature information on identification (particularly differences between the sexes and the various age groups), biology, management plans and programs, research programs and potential viewing opportunities. Additional information on hunting should also be available on the web in the annual *Alberta Guide to Hunting Regulations* when there is a hunting season. Mountain goat information could be featured in wildlife conservation education materials used by other agencies such as the Conservation Education WISE Foundation and within the Alberta school curriculum.

3.3.6 Managing Commercial Use

Due to the small number of goats, their relative inaccessibility and their requirements for security from human disturbance, commercial opportunities are limited.

3.3.6.1 *Outfitting and Guiding*

Opportunities for economic benefits from non-consumptive uses of goats could be provided in situations compatible with other objectives of goat management. For example, goat watching could be one focus for adventure tours offered by outfitters. As with other users, care would have to be taken to avoid harassment and disturbance of the goats.

Guiding resident hunters in remote areas would also enhance the commercial opportunities for Alberta outfitters and guides. Current policy does not provide any non-resident or non-resident alien goat hunting opportunities.

3.3.6.2 *Zoological Display*

Zoos must have a licence to hold and propagate goats for public display, study, photography and sale of live animals to other legal operations. The provision of goats for zoos would be accommodated by injured or orphaned goats wherever possible. By providing initial stock and the opportunity for zoos to possess and propagate goats, a source of captive stock would become available for zoological display, as well as some scientific and educational uses. Regulations should ensure that captive goats are kept isolated from wild herds and that they are kept in an appropriate facility where they can be managed in a safe and humane manner.

4.0 MANAGEMENT PLAN APPLICATION

4.1 PROVINCIAL SUMMARY

The primary challenges for management of mountain goats in Alberta are to:

- Maintain existing populations at goal levels and retain the necessary habitat to meet these goals.
- Rebuild reduced populations and repopulate ranges where herds have been extirpated.
- Develop opportunities for enjoyment of goats by non-consumptive users.
- Develop hunting strategies to harvest goats in a sustainable fashion.
- Expand research efforts beyond Goat Management Area D to the other three GMAs in Alberta.

A substantial effort will be required to protect habitat and allow natural population recovery in under-stocked ranges in order to achieve the targeted increase of 538 goats. Population surveys must be more frequent and regular in order to satisfy the criteria for opening and maintaining hunting seasons. Viewing opportunities should be developed near human population centers and transportation corridors where there is high demand for non-consumptive use of goats.

To meet the established population goals, it is essential to identify all critical goat ranges, particularly the core cliff areas, and protect them from development and human activity. Recreational activity, such as hiking, rock climbing and heli-tourism, is of special concern. Finally, additional comprehensive studies of goat population dynamics are recommended for Goat Management Areas A, B and C. Good management of a species requires a thorough understanding of its biology and limiting factors, which have not been well documented for goats.

Co-operative programs should be developed for those herds that use habitat along the boundaries of British Columbia, Waterton Lakes National Park, Banff National Park and Jasper National Park. Surveys of these herds should involve all appropriate agencies and cover both sides of the borders. When hunting seasons are open along the Continental Divide, harvest quotas must be established in conjunction with British Columbia because the goats in this area move back and forth between the provinces, making them available to hunters in both provinces.

Provincial standards for data collection, data storage, data analysis and report preparation must be established.

4.2 GOAT MANAGEMENT AREA PERSPECTIVE

4.2.1 Goat Management Area A

The current population estimate for Goat Management Area (GMA) A is 252 goats (Table 12), which is 15 percent of the total on provincial lands. The total population goal for the four surveyed Goat Population Areas (GPAs) in this GMA is 235 goats (Table 15). The goal has been exceeded in three of the four GPAs, whereas one GPA requires a modest increase of 5 goats to meet the goal. Therefore, the management focus will be to maintain the population at these goals, to protect the current goat habitat and to provide a sustainable harvest. Wildlife managers from both Alberta and British Columbia must work together because many of the goats in this GMA inhabit areas on both sides of the provincial borders.

4.2.2 Goat Management Area B

The current population estimate for Goat Management Area A is 345 goats (Table 12), which is 21 percent of the total on provincial lands. This GMA has experienced sharp declines in the past. The population goal for the three surveyed GPAs is 170 goats (Table 15). The goal has been exceeded in one of the three GPAs, whereas two areas have a goal of increasing the number of goats by 49 and 19 respectively. The primary objective of goat management in this GMA is to protect goat ranges from human disturbance and encourage maximum goat population expansion. The one GPA that could be opened for hunting in the future is well below the goal. As a result of the limited opportunity for recreational hunting, the primary use of goats in this area will be non-consumptive. However, because goat populations in this GMA are close to major urban and tourist activity centers, the level of disturbance associated with recreational activities and developments on goat ranges will have to be closely monitored.

4.2.3 Goat Management Area C

The current population estimate for Goat Management Area C is 195 goats (Table 12), which is 12 percent of the total on provincial lands. The population goal for the seven surveyed GPAs is 279 goats (Table 15). Goats in this GMA exist in areas ranging from remote wilderness to those affected by a multitude of industries and intense human activity. Two of the seven surveyed GPAs have met the goal. The five GPAs below the goal have a target of 139 more goats before they reach goal levels. The two GPAs that could be opened for hunting in the future are well below the goal. Population growth and protection of habitat from increasing industrial activities are the two main management objectives in this GMA.

4.2.4 Goat Management Area D

The current population estimate for Goat Management Area D is 860 goats, which is 52 percent of the total on provincial lands (Table 12). The population goal for the 18 surveyed GPAs is 1059 goats compared with the current estimate of 788 goats (Table 15). Seven of the 18 survey areas have met the population goals whereas the other 11 GPAs must increase their total number of goats by 42 percent (349 goats). Caw Ridge in WMU 446, is a surveyed GPA, and the current population estimate of 101 is above the goal of 76 (Table 15). However, this research herd will not be available for hunting. The ongoing research on Caw Ridge provides some of the best information on goat ecology in North America. Ten of the 18 surveyed GPAs could be opened for hunting in the future when they satisfy all the criteria to open a season. The primary objectives for this GMA are to manage the goat population for a sustainable harvest and to protect the habitat. Goats are affected by various industrial activities, but coal development requires special consideration to ensure goat habitat is maintained. Timber harvest and access are also concerns for the small Pinto Creek goat population.

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6.0 APPENDICES

Appendix 1. History of transplanted mountain goats in Alberta from 1972 to 1995 (Jorgenson and Quinlan 1996, K.G. Smith et al. 1996) and 1996 to 1998 (Natural Resources Service data files). There were no transplants between 1995 and 2000.

Goat I.D.	Source	Release	Date	Sex	Age	Collar	L. Ear	R. Ear	Dispersal	Kids	Mortality	Last Seen
72-01	Goat Cliffs/Grande	Shunda Mt.	-	M	-	-	-	-	-	-	-	-
72-02	Goat Cliffs/Grande	Shunda Mt.	-	M	-	-	-	-	-	-	-	-
72-03	Goat Cliffs/Grande	Shunda Mt.	-	F	-	-	-	-	Yes	-	-	-
72-04	Goat Cliffs/Grande	Shunda Mt.	-	F	Old	-	-	-	-	-	-	-
72-05	Goat Cliffs/Grande	Shunda Mt.	-	F	Old	-	-	-	-	-	-	-
72-06	Goat Cliffs/Grande	Shunda Mt.	-	F	Old	-	-	-	-	-	-	-
72-07	Goat Cliffs/Grande	Shunda Mt.	-	F	Old	-	-	-	-	-	-	-
86-1	Caw Ridge	Picklejar	01-Aug-86	F	-	-	-	-	-	-	-	-
86-2	Caw Ridge	Picklejar	01-Aug-86	F	-	-	-	-	-	92	-	-
87-1	Caw Ridge	Livingstone	05-Jun-87	M	10	Wt	-	-	-	-	-	-
87-2	Caw Ridge	Livingstone	05-Jun-87	M	5+	-	None	Or 23	-	-	-	-
87-3	Caw Ridge	Livingstone	05-Jun-87	M	5+	-	Bl 24	None	-	-	-	-
87-4	Caw Ridge	Livingstone	17-Jun-87	F	3	Bk	Or 19	None	-	-	-	Jul-89
87-5	Caw Ridge	Livingstone	17-Jun-87	F	8	-	Bk 102	Bk 101	-	-	-	-
87-6	Caw Ridge	Livingstone	24-Jun-87	F	8	-	Or 7	Gr 41	-	-	-	-
87-7	Caw Ridge	Livingstone	24-Jun-87	F	7	-	Bl 50	Or 14	-	-	-	Jul-90
87-8	Caw Ridge	Livingstone	24-Jun-87	M	6	-	Bl 47	Or 14	-	-	-	Jul-90
87-9	Caw Ridge	Livingstone	24-Jun-87	F	6	-	Gr 44	Gr 49	-	-	-	-
88-1	Caw Ridge	Livingstone	23-Jun-88	F	4+	Dark	None	Yl	-	-	-	Aug-90
88-2	Caw Ridge	Livingstone	23-Jun-88	M	6	-	Yll	None	-	-	-	-
92-1	Mt. Hamell	Livingstone	03-Jul-92	F	3	Wt	Yl	R 53	No	93	Poached	Nov-93
92-2	Mt. Hamell	Livingstone	08-Aug-92	F	3	Wt	None	Or 4	No	93-95	-	Dec-92
93-01	Lillooet, B.C.	Picklejar	26-Aug-93	F	7	Bk	Or 72	Wt 70	Yes	-	-	-
93-12	Lillooet, B.C.	Picklejar	26-Aug-93	F	9	Yl	-	-	Yes	-	Fall	May-94
93-13	Lillooet, B.C.	Picklejar	26-Aug-93	F	1	-	Gr 86	None	-	-	-	-
93-02	Lillooet, B.C.	Picklejar	27-Aug-93	M	1	-	P 52	Or 71	-	-	-	-
93-03	Lillooet, B.C.	Picklejar	27-Aug-93	M	2	R	Gr 59	R 21	No	-	-	-
93-04	Lillooet, B.C.	Picklejar	27-Aug-93	F	1	-	Gr 53	Or 74	-	-	-	-
93-05	Lillooet, B.C.	Picklejar	27-Aug-93	F	2	Gr	P 54	P 60	Yes	-	Unknown	Jan-96

Appendix 1 continued next page

Appendix 1 continued

Goat I.D.	Source	Release	Date	Sex	Age	Collar	L. Ear	R. Ear	Dispersal	Kids	Mortality	Last Seen
93-06	Lillooet, B.C.	Picklejar	27-Aug-93	F	7	Yl/R	Wt 74	Wt 72	Yes	-	-	-
93-07	Lillooet, B.C.	Picklejar	27-Aug-93	F	1	-[a]	None	P 51	-	-	-	-
93-08	Lillooet, B.C.	Picklejar	27-Aug-93	F	6	Wt/R	None	Gr 56	-	-	Grizzly	Sep-93
93-09	Lillooet, B.C.	Picklejar	27-Aug-93	M	1	-	None	P 53	-	-	-	-
93-10	Lillooet, B.C.	Picklejar	27-Aug-93	M	6	-	-	-	-	-	-	-
93-11	Lillooet, B.C.	Picklejar	27-Aug-93	M	1	-	-	-	-	-	-	-
93-14	Lillooet, B.C.	Picklejar	27-Aug-93	F	5	Yl/Bk	P 88	None	Yes	-	Unknown	Mar-96
93-15	Lillooet, B.C.	Picklejar	27-Aug-93	F	6	-	None	Bk 20	-	-	-	-
93-16	Lillooet, B.C.	Picklejar	27-Aug-93	F	3	-	Yl 95	None	-	-	-	-
93-17	Lillooet, B.C.	Picklejar	27-Aug-93	M	1	-	Bl 83	None	-	-	-	-
93-18	Lillooet, B.C.	Picklejar	27-Aug-93	F	6	R/Bl	None	Yl 96	Yes	-	Unknown	Aug-94
93-19	Lillooet, B.C.	Picklejar	27-Aug-93	F	1	-	Bk 18	None	-	-	-	-
93-20	Lillooet, B.C.	Picklejar	27-Aug-93	F	5	-	None	Bl 85	-	-	-	-
93-21	Lillooet, B.C.	Picklejar	27-Aug-93	F	2	-	Wt 250	None	-	-	-	-
93-01	Lillooet, B.C.	Livingstone	28-Aug-93	F	5	Bl	Yl	None	No	95	-	-
93-02	White River, B.C.	Livingstone	31-Aug-93	F	3	Bl/Wt	R	Bl	Crowsnest Mtn.	94-97	-	-
93-03	White River, B.C.	Livingstone	31-Aug-93	F	1	-	P	None	Unknown	-	-	-
93-04	White River, B.C.	Livingstone	31-Aug-93	M	7	R/Gr	None	P	No	-	Capt. Myop.	Sep-93
93-05	White River, B.C.	Livingstone	31-Aug-93	F	1	-	P	Yl	Unknown	-	-	-
94-01	White River, B.C.	Livingstone	25-Aug-94	F	4	Yl/Bk ///	Yl	Or	No	95?	-	-
94-02	White River, B.C.	Livingstone	25-Aug-94	M	2	Or/Bk ●	Gr	R	No	-	Unknown	Nov-94
94-03	White River, B.C.	Livingstone	25-Aug-94	F	2	Bl/Bk ///	P	Or	Crowsnest Mtn.	96?/97/98	-	-
94-04	White River, B.C.	Livingstone	25-Aug-94	F	5	Bl/Bk ●	Bl	Or	Crowsnest Mtn.	97?	-	-
94-05	White River, B.C.	Livingstone	25-Aug-94	F	6	Yl/Bk ●	Bl	Or	No	-	Unknown	Jul-97
94-06	White River, B.C.	Livingstone	25-Aug-94	F	3	Bl/Bk <<	Bl	Gr	Unknown	-	-	-
95-01	Klingzut/Moose, B.C.	Trap Creek	03-Aug-95	F	5	Or/Bk T	-	-	No	-	-	-
95-02	Klingzut/Moose, B.C.	Trap Creek	03-Aug-95	F	4	Or/Bk X	-	-	Yes	-	-	-
95-03	Klingzut/Moose, B.C.	Trap Creek	03-Aug-95	F	4	R/Bk ///	-	-	-	-	-	-
95-04	Klingzut/Moose, B.C.	Trap Creek	03-Aug-95	F	6	Yl/Bk N	-	-	-	-	-	-
95-05	Klingzut/Moose, B.C.	Trap Creek	03-Aug-95	M	2	-	Or 1	Or 2	-	-	-	-

Appendix 1 continued next page

Appendix 1 continued

Goat I.D.	Source	Release	Date	Sex	Age	Collar	L. Ear	R. Ear	Dispersal	Kids	Mortality	Last Seen
95-06	Klingzut/Moose, B.C.	Trap Creek	03-Aug-95	M	1	-	Yl 30	Bk 29	-	-	-	-
95-07	Klingzut/Moose, B.C.	Trap Creek	03-Aug-95	F	5	Yl/Bk ----	-		-	-	-	-
95-08	Klingzut/Moose, B.C.	Trap Creek	03-Aug-95	F	1	-	Bl 35	Bl 44	-	-	-	-
95-09	Klingzut/Moose, B.C.	Trap Creek	03-Aug-95	M	3	-	Or 16	Bl 42	-	-	-	-
95-10	Klingzut/Moose, B.C.	Trap Creek	03-Aug-95	M	5	Bl/Bk ◆	-		Yes	-	-	-
95-11	Klingzut/Moose, B.C.	Trap Creek	03-Aug-95	M	2	-	Bl 38	Yl 31	-	-	-	-
95-12	Klingzut/Moose, B.C.	Trap Creek	03-Aug-95	F	2	Or/Bk ◆	-		-	-	-	-
95-13	Klingzut/Moose, B.C.	Trap Creek	03-Aug-95	F	1	-	Yl 32	R 80	-	-	-	-
95-14	Klingzut/Moose, B.C.	Trap Creek	03-Aug-95	M	1	-	P 25	Yl 47	-	-	-	-
95-15	Klingzut/Moose, B.C.	Trap Creek	03-Aug-95	F	2	Or/Bk N	-	-	-	-	-	-
95-16	Klingzut/Moose, B.C.	Trap Creek	03-Aug-95	F	1	-	P 24	R 78	-	-	-	-
95-17	Klingzut/Moose, B.C.	Trap Creek	03-Aug-95	M	1	-	Or 15	P 23	-	-	-	-
95-18	Klingzut/Moose, B.C.	Trap Creek	03-Aug-95	F	2	Yl/Bk ■	-	-	-	-	-	-
95-19	Klingzut/Moose, B.C.	Trap Creek	03-Aug-95	M	1	-	Yl 28	Bl 39	-	-	-	-
95-20	Klingzut/Moose, B.C.	Trap Creek	03-Aug-95	F	3	Yl/Bk	-	-	Yes	-	-	-
95-21	Cline/Hamell	Nihahi	04-Aug-95	M	2	Or/Bk V	-	-	-	-	-	-
95-22	Cline/Hamell	Nihahi	04-Aug-95	M	2	-	P 16	Bl 48	-	-	-	-
95-23	Cline/Hamell	Nihahi	04-Aug-95	F	5	Bl/Bk ■	-	-	Yes	-	-	-
95-24	Cline/Hamell	Nihahi	04-Aug-95	F	2	Bl/Bk N	-	-	Yes	-	-	-
95-25	Cline/Hamell	Nihahi	04-Aug-95	F	2	Or/Bk ----	-	-	-	-	-	-
95-26	Cline/Hamell	Nihahi	04-Aug-95	F	4	Bl/Bk ▼	-	-	Yes	-	-	-
95-27	Cline/Hamell	Nihahi	04-Aug-95	F	3	Yl/Bk ▼	-	-	-	-	-	-
95-28	Cline/Hamell	Nihahi	04-Aug-95	F	2	Bl/Bk ----	-	-	-	-	-	-
95-29	Cline/Hamell	Nihahi	04-Aug-95	F	4	Or/Bk ///	-	-	Yes	-	-	-
95-30	Cline/Hamell	Nihahi	04-Aug-95	F	1	-	Bl 44	Or 7	-	-	-	-
95-31	Cline/Hamell	Compression	06-Aug-95	F	1	-	R	Yl 43	-	-	-	-
95-32	Cline/Hamell	Compression	06-Aug-95	F	1	-	R	R	-	-	-	-
95-33	Cline/Hamell	Compression	06-Aug-95	F	3	Yl/Bk V	-	-	Yes	-	-	-
95-34	Cline/Hamell	Compression	06-Aug-95	F	3	Bl/Bk T	-	-	-	-	-	-
95-35	Cline/Hamell	Compression	06-Aug-95	M	2	Bl/Bk X	-	-	-	-	-	-
95-36	Cline/Hamell	Compression	06-Aug-95	F	2	Yl/Bk X	-	-	-	-	-	-

Appendix 1 continued next page

Appendix 1 continued

Goat I.D.	Source	Release	Date	Sex	Age	Collar	L. Ear	R. Ear	Dispersal	Kids	Mortality	Last Seen
95-37	Cline/Hamel	Compression	06-Aug-95	F	5	Bl	-	-	-	-	-	-
95-38	Cline/Hamell	Compression	06-Aug-95	F	3	Or/Bk ■	-	-	-	-	-	-
95-39	Cline/Hamell	Compression	06-Aug-95	F	3	-	Yl 38	Or 5	Yes	-	-	-
95-40	Cline/Hamell	Compression	06-Aug-95	F	3	-	Or 6	Yl 42	Yes	-	-	-
95-01	White River, B.C.	Barnaby	30-Aug-95	F	4	Or/Bk	R	R	Sage Ck., B.C.	-	Wolf	Sep-96
95-02	White River, B.C.	Barnaby	30-Aug-95	F	4	Or/Bk	R	Gr	Syncline Mtn., AB	-	Fall	Sep-96
95-03	White River, B.C.	Barnaby	30-Aug-95	M	2	Bk/Or	R	Yl	St. Eloi Ck., B.C.	-	Unknown	May-98
95-04	White River, B.C.	Barnaby	30-Aug-95	F	4	Or/Bk	R	Bl	No	-	-	-
95-05	White River, B.C.	Barnaby	30-Aug-95	F	4	Bk	R	P	Lost Lk., Waterton	-	Unknown	Jul-98
95-06	White River, B.C.	Barnaby	30-Aug-95	F	3	Yl/Bk	R	Or	Unknown	-	Faulty Collar	-

Wt-White, Bk-Black, Bl-Blue, Yl-Yellow, R-Red, Gr-Green, Or-Orange, P-Purple.

■ = square, ▼ = triangle, /// = stripes, << = chevron, ♦ = diamond, ● = circles.

[a] The dash means data not available.

Appendix 2. A summary of mountain goat hunting seasons in Alberta, 1907-1987 (Hall 1977 and Alberta Regulations). The goat hunting season has been closed since 1988.

Years	Season Dates	Days	Limit	Applications	Special Licences	Open and Restricted Areas
1907-08	No season					
1909-18	1 Sep-14 Oct	37-38	2	-b	Unlimited	Entire province open
1919-20	1 Sep-31 Oct	52-53	2	-	-	Entire province open
1921-22	1 Sep-31 Oct	52	2[a]	-	-	Entire province open
1923-34	1 Sep-31 Oct	52-53	1	-	-	Entire province open
1935-38	1 Sep-31 Oct	52-53	2	-	-	Entire province open
1939-48	1 Sep-31 Oct	52-53	1	-	-	Entire province open
1949	15 Sep-15 Oct	27	1	-	-	Entire province open
1950	15 Sep-31 Oct	40	1	-	-	Entire province open
1951-53	1 Sep-15 Oct	38-39	1	-	-	Entire province open
1954-55	1 Sep-30 Oct	52	1	-	-	Entire province open
1956	1 Sep-13 Oct	37	1	-	-	Entire province open
1957	2 Sep-31 Oct	53	1	-	-	Zone 8 closed for rifles; S410 open for bow hunting
1958	1 Sep-31 Oct	53	1	-	-	Special Areas 1, 2, and 3; Zone 8 restricted to archery only
	1 Sep-30 Oct	52	1	-	-	South of the Bow
	1 Sep-18 Oct	42	1	-	-	North of the Bow
1959	1 Sep-31 Oct	53	1	-	-	Special Areas 1, 2, and 3
	1 Sep-17 Oct	41	1	-	-	Zones 1-15
1960	1 Sep-29 Oct	51	1	-	-	Zones 1-8, 12-15 and Special Areas
	1 Sep-22 Oct	45	1	-	-	Zones 9 and 10
1961	1 Sep-28 Oct	50	1	-	-	Zones 1-8, 12-15 and Special Areas
	1 Sep-21 Oct	44	1	-	-	Zones 9 and 10
1962	1 Sep-31 Oct	52	1	-	-	Zones 1-8, 12-15 and Special Areas
	1 Sep-20 Oct	43	1	-	-	Zones 9 and 10
1963	31 Aug-2 Nov	55	1	-	-	Zones 12-15; Special Areas
	31 Aug-26 Oct	49	1	-	-	Zones 1-10
1964	1 Sep-31 Oct	53	1	-	-	S400-444
1965	1 Sep-30 Oct	52	1	-	-	S400-444
1966	1 Sep-30 Nov	78	1	-	-	S440-442 (S444 closed)
	1 Sep-29 Oct	50	1	-	-	S400-438
1967	1 Sep-31 Oct	52	1	-	-	S400-438, S440 and 442
1968	31 Aug-31 Oct	53	1	-	-	S440, 442, and 410
	21 Sep-5 Oct	13	1	-	-	S412-438 and S408
1969[c]	21 Sep-18 Oct	28	1	-	-	Willmore Special Area only.
1970-71	Closed			-	-	
1972	2 Oct-15 Oct	14	1	-	75[d]	Portion of S442

Appendix 2 continued next page

Appendix 2 continued

Years	Season Dates	Days	Limit	Applications	Special Licences	Open and Restricted Areas
1973	3 Oct-13 Oct	13	1	-	52	To be taken in area of designation
1974	30 Sep-12 Oct	13	1	-	53[e]	GHAs A, B, C, E
1975	29 Sep-11 Oct	13	1	148	55[f]	A, B, C, D, E, F
1976	27 Sep-9 Oct	13	1	163	48	A, B, C, D, E, F
1977	26 Sep-9 Oct	13	1	241	50	A, B, C, D, E, F
1978	26 Sep-9 Oct	13	1	-	46	A, B, C, D, E, F
1979	26 Sep-9 Oct	13	1	389	47	A, B, C, D, E, F
1980	26 Sep-9 Oct	13	1	463	42	A, B, C, D, E, F
1981	26 Sep-9 Oct	13	1	457	45	A, B, C, D, E, F
1982	26 Sep-9 Oct	13	1	489	44	A, B, C, D, E, F
1983	26 Sep-9 Oct	13	1	624	46	A, B, C, D, E, F
1984	26 Sep-9 Oct	13	1	599	34	A, B, C, D, E, F
1985	26 Sep-9 Oct	13	1	527	32	A, B, C, D, E, F, G, H, I
1986	26 Sep-9 Oct	13	1	1924	35	A, B, C, D, E, F, G, H, I, M, O, Q, R
1987	26 Sep-9 Oct	13	1	1186	16	B, C, F, G, H, I, M, O, Q, R

[a] From 1921-1949, harvest was restricted to goats >1 year old or with horns at least 4 inches (10 cm) long; this restriction was reinstated in the early 1970s.

[b] The dash means data not available.

[c] Sunday hunting initiated in the Green Area.

[d] Special Licence draw started in 1972.

[e] Permits valid in specified area only.

[f] Compulsory registration

Appendix 3. The estimated mountain goat harvest in Alberta from 1950-1987. Numbers were obtained from Hall (1977) and a variety of other sources including hunter questionnaires, annual reports and registrations.

Year	Resident Harvest	Non-resident Harvest Canadian	Non-resident Harvest Alien	Non-resident Harvest Combined	Native Harvest	Other Harvest	Total Harvest
1950	150	-[c]	50	50	-	-	200
1951	90	-	90	90	-	-	180
1952	20	2	60	62	-	-	82
1953	70	-	40	40	-	-	110
1954	123	-	44	44	-	-	167
1955	74	-	54	54	-	-	128
1956	140	3	90	93	-	-	233
1957[a]	72	-	-	45	-	-	117
1958[a]	97	-	-	60	-	-	157
1959[a]	129	-	-	81	-	-	210
1960[a]	139	-	-	86	-	-	225
1961	116	-	-	65	-	-	181
1962	169	-	-	89	-	-	258
1963	131	-	-	123	-	-	254
1964	124	-	-	87	-	-	211
1965	98	-	-	96	-	-	194
1966	84	-	-	111	-	-	195
1967	57	-	-	69	-	-	126
1968	40	-	-	45	-	-	85
1969	22	-	-	32	-	-	54
1972[b]	22	-	-	-	-	-	22
1973	14	-	-	-	-	-	14
1974	13	-	-	-	-	-	13
1975	28	-	-	-	-	-	28
1976	29	-	-	-	-	-	29
1977	17	-	-	-	-	-	17
1978	23	-	-	-	-	-	23
1979	33	-	-	-	-	-	33
1980	24	-	-	-	-	-	24
1981	32	-	-	-	-	-	32
1982	23	-	-	-	-	-	23
1983	26	-	-	-	0	0	26
1984	8	-	-	-	2	0	10
1985	6	-	-	-	5	0	11
1986	24	-	-	-	1	1	26
1987	13	-	-	-	-	-	13

[a] Kill estimates were extrapolated.

[b] Season closed in 1970-71.

[c] The dash means data not available.

Appendix 4. Cover sheet for mountain goat surveys in Alberta.

Aerial Survey and Telemetry Cover Sheet

Please file this cover sheet with the survey data.

Date: ____________
yy / mm / dd

General Area: ____________

Type of Survey: Caribou Sheep Goat Moose Other: ____________

Survey Method: Telemetry Transect Range Drainage
Quadrat Watercourse Random Stratified Blocks

Pilot: ____________ Navigator: ____________ Aircraft: ____________

Observers: ____________

Temp: ____________

Wind: ____________ Start Time: ____________

Visibility: ____________ Stop Time: ____________

Snow Cover*: ____________ Flying Time: ____________

Snow Depth: Station #1 ____________ Station #2 ____________

Behavioral Observations:

____

____

____

Comments:

____

____

____

*Snow 1 = 0-10%; 2 = 11-50%; 3 = 51-90%; 4 = 91-100%

Appendix 5. Data sheet for mountain goat surveys in Alberta.

Data Sheet for Goat Surveys

Date: ______________ Location: ____________________ Page: ____ of ____

Complex	Time/Ckpt	Goats						Sheep										Other	NAD 27 or NAD	
		Total	Adult					Total	Non-Ram			Ram					U/C			
			B	N	U/C	Yrlg	Kids		Ewe	Lamb	U/C	1/4	1/2	3/4	Legal	U/C			Lat	Long